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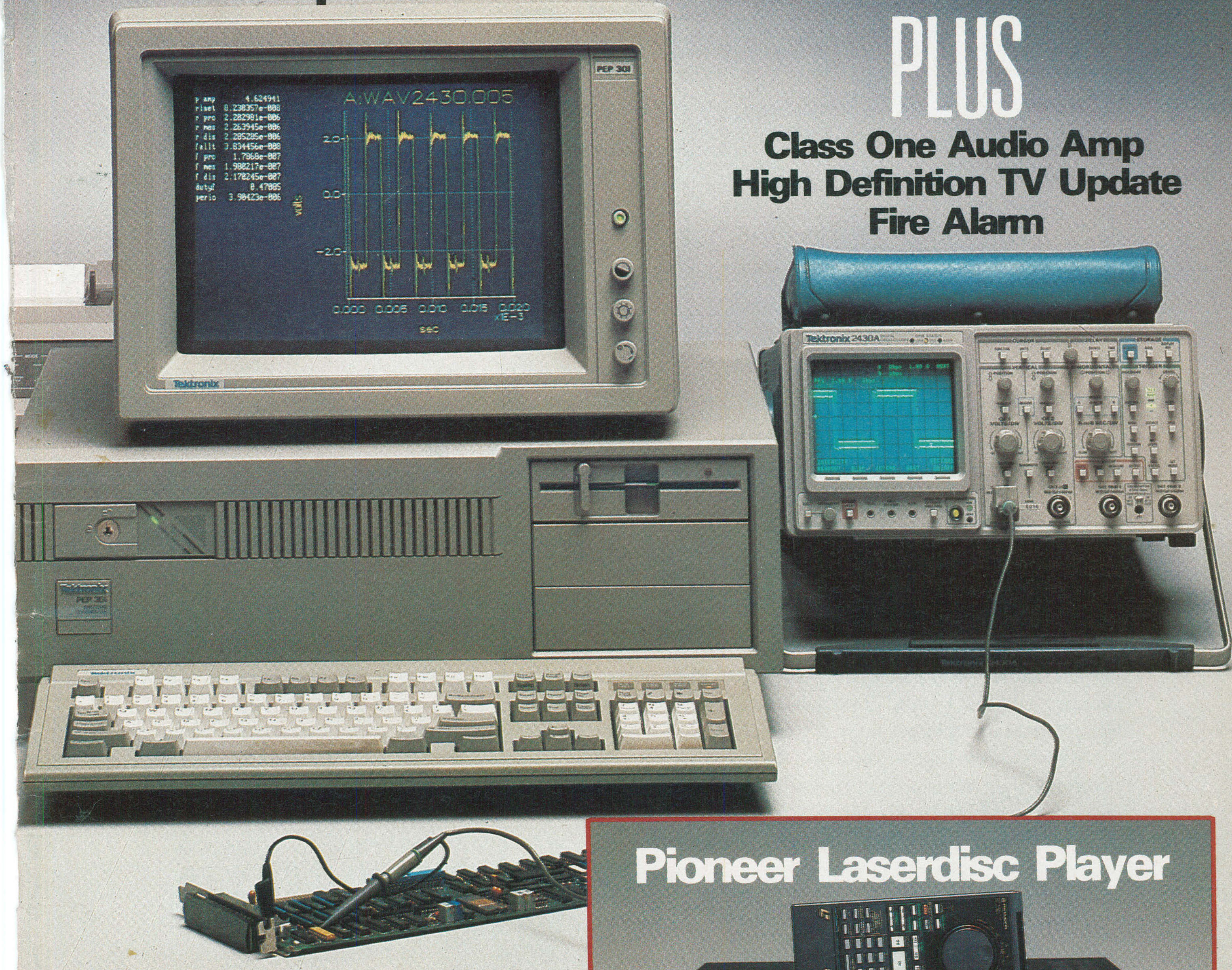

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Our Cover

The ATE setup is courtesy of Tektronix Canada Ltd.; the photo of the Laserdisc Player is courtesy of Pioneer Electric.

FEATURES

TECHNOLOGY

PRODUCT REVIEW

PROJECTS

INFORMATION

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FOR YOUR INFORMATION

PCB Test Service

KJ Marketing of Toronto has introduced a testing service for manufacturer's printed circuit boards, using Automated Test Equipment (ATE). The service is said to increase production while decreasing the cost of testing; up to 100 boards an hour can be handled. All requirements and services can be met or provided, including testability studies, program design, fine tuning, yield tracking, etc. Contact them at 36 Belvia Road, Toronto, Ontario M8W 3R3, (416) 252-1061.

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PCB SUPPLIERS: We do not supply printed circuits or kits, and we do not keep track of availability. However, PCBs for projects are availble from the following mail order sources:
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K.S.K. Associates, PO Box 266, Milton, Ontario L9T 4N9.
Spectrum Electronics, 14 Knightswood Crescent, Brantford, Ontario N3R 7E6.

Wide-range Cellular

Bell Cellular has announced a new service called "Follow-Me Roaming". This enhanced call-forwarding service allows subscribers travelling outside their system to have calls forwarded to other provinces or the US. When users enter an area serviced by another participating cellular company, they dial a three-digit access code and all incoming calls to their home-based number are automatically forwarded to the new area. The service is offered at no charge, though users still pay for long-distance and air time.

Diamond Thin Films

Industrial diamonds have long been used in such applications as abrasives, but now researchers have developed a way to make extremely thin films by using microwave energy to strip the hydrogen atoms from methane gas, leaving a plasma of carbon atoms which link together to form the film. Sony and Onkyo have been using the film for loudspeaker tweeters, and Sumitomo is making pre-production samples of diamond thin film semiconductors. Crystallume Corporation in the US is using the technique to make ultra-thin windows for medical instruments, and other uses include coatings for edge tools, optics and even window glass. Semiconductors could be faster and more durable than gallium arsenide. Still in the early stages of commercial use, the technology may develop into a $200 million market by 1991.

V/C Calibrators

Electronic Development Corporation of Boston, Mass., makers of a full range of voltage and current calibrators, announces that the Canadian agent is Omnitronix Ltd., 2410 Dunwin Drive, Mississauga, Ontario L5L 1J9, (416) 828-6221, and also 8100F Trans-Canada Highway, St. Laurent, Quebec H4S 1M5, (514) 337-9500.

Tech Job Growth Flattens

Job vacancies for engineers and scientists was unchanged in the last quarter of 1988, according to the Technical Service Council of Toronto, contrasting with the 25% in-

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crease in openings in the previous 12 months. The figures suggest regional economic growth is becoming more balanced, and the trend will probably continue in 1989. Greatest demand in the technical field: systems analysts and programmmers. There is also a perpetual demand for technically skilled salepeople, since engineering graduates are rarely interested in sales.

Buying a Clone

We're often asked for advice on buying computers, especially the question of buying a low-cost import versus a big-name brand. In general, we've found that the clones are an excellent buy, with two reservations. The first is that the quality control is not quite up to that of the name brands, and you may have to make several trips back to the dealer to correct various problems that crop up after a few days or weeks of operation. The second is that compatibility may be a problem with some of the more complicated software and hardware. The manuals, if any, are rarely of any help when it comes to understanding system configuration changes. If you live in an area remote from any dealers, you may be without your computer for quite a while, should you have any teething problems with it.

Speaking of installation problems and poor documentation, there can't be many more things as frustrating as trying to install a hard drive in an AT compatible. There are two types of controllers, neither one labelled with its type. There seems to be an infinity of disk drives; the Setup program in the AT asks you for the drive type, and the list of numbers bears no relation to the drive manufacturer's designations. If there are jumpers or DIP switches to set, you might better give up and pack the thing back to the dealer.

New Microphones

Bruel & Kjaer, makers of high-quality test equipment for acoustical work, have announced a new line of cardioid professional microphones, the Type 4011. They are particularly suited to recording popular and classical music with digital recording techniques. All microphones can be complemented by a complete range of accessories. For further information, contact Bruel & Kjaer Canada Ltd., 90 Leacock Road, Pointe Claire, Quebec H9R 1H1, (514) 695-8225.

Circle No. 3 on Reader Service Card

Lotus Measure

National Instruments has been given the exclusive right to market the Lotus Measure software system. Lotus Measure is a system for scientific applications requiring data acquisition and instrument control; it includes a set of data acquisition drivers for Lotus 1-2-3 and Symphony that allows data to be acquired, formatted and stored directly into the spreadsheet. All functions in the spreadsheet are available for immediate reduction, analysis and textual or graphics presentation.

Lotus Measure provides for the acquisition of data using GPIB (General Purpose Instrumentation Bus), RS232 and analog-to- digital interfaces. The GPIB routines provide 21 macro commands for using National Instrument interfaces. For more information, contact the exclusive Canadian representative for National Instruments, Allan Crawford Associates Ltd., Technology Marketing Concepts, 5835 Coopers Ave., Mississauga, Ontario L4Z 1Y2, (416) 890-2010, Fax 890-1959.

Circle No. 4 on Reader Service Card

Power Amp Tester

Sencore has introduced the PA81 Stereo Power Amplifier analyzer. It measures power to 250W with loads from 2 to 32 ohms, and includes an external input voltmeter calibrated in volts RMS and decibels for audio signal tracing. The inputs measure both channel's DC balance and disconnect if out of balance by more than 1V. Contact Sencore, PO Box 248, Sta. L, Winnipeg, Manitoba R3H 0Z5, 1-800-851-8866.

Circle No. 5 on Reader Service Card

FEATURE

Automated Test Equipment

Demonstrating computer control of test equipment with a simple analog ATE system.

ROGER STONE

Suppose that you need a Automatic Test Equipment (ATE) set-up for testing of analog-type devices: components, subassemblies, final products, whatever. Until now, there have been basically three possible approaches:

1. Buy and Integrate: buy the individual computer-controllable instruments (DVM, frequency meter, power supplies, waveform generators, switching system, etc). You may not have much change out of $15,000.00, if you want general-purpose capability.

Now bolt them into a rack, put a "488" controller card in your computer, and run 488 cables to all of the instruments. This costs another few hundred dollars and some effort.

Now you'll need some arrangement for connecting the outputs of all the instruments to your UUT (unit under test), and for building any special circuitry required for testing a given UUT. Don't forget that each UUT will have different requirements in these areas.

Finally, read all the various manuals, and reconcile some of them with each other, to make the system work.

Such a system is too costly to replicate, and too cumbersome to move around. So, it becomes a central facility, to which all work is brought. But then, it probably needs a resident guru to run it anyway, just as computer systems used to (remember those days?).

2. Cobble Together: buy boards which plug into your computer's internal busses, to perform specific ATE functions, such as generating waveforms, making measurements, etc. You can also buy sub-systems which are housed outside the computer, coupling into it via some special bus, and a special interface card plugged into the PC's internal busses.

Most of these offerings are not specifically ATE-oriented, e.g., the measurement functions do not have floating inputs, and do not handle current signals. Some functions cannot be

addressed at all, e.g. power supplies.

The ATE system is rather intimately involved with the computer, electrically. It connects to the computer's ground, and may suffer from its internal noise.

Again, you have a lot of manuals to read, and you have to do the work to integrate the whole assemblage into a system, and accommodate different UUTs.

3. Roll-Your-Own: design and build your own ATE from scratch. This might seem like fun, but can be very time-consuming for any but the most trivial applications.

Here at least you don't have to read manuals: you just have to write one.

The software interface is likely to be rather rudimentary, and the resulting programs fairly unreadable, at least by anyone but the original programmer.

Of course, you can go with a combination of the above methods.

PILOT

Now, a Canadian company has addressed this situation with a product called the PILOT ("Programmable Integrated LOw-cost Tester"). It is intended to address most ATE requirements in the analog area, and has the following features: minimal cost, at $2700, Canadian, easy learning with software commands all listed on one page, no integration, except to plug a cable into the serial port of your computer, and minimum work to make a fixture for each device to be tested.

The PILOT provides in one small box all the instrument functions usually needed for analog-type circuit testing of assemblies, components, or final products. It places these functions under the control of an external computer, as shown in Figure 1.

Figure 2 depicts the applications connector of the PILOT, on which all the functions appear. Ranges and ratings are shown. These functions are described later.

DC Supplies

These three supplies cover the most common requirements of analog and digital circuitry. Each can be programmed continuously over its ranges of voltage current-limit. Output voltages and load currents can be read out by the computer. Some examples of commands are: P1V=10 (set #1 Power Supply output to 10V), P2C=0.2 (set #2 Power Supply current limit to 0.2 Amps), and RIP3 (Read the output current drawn from #3 Power Supply).

Waveform Generators

Each Waveform Generator (WG) can output sine, square, triangle and sawtooth waveforms. The amplitude, frequency and baseline offset are programmable. For example, the software commands **W1SIN, W1F=2375, W1A=12, W1B=-3, W1ON** set up WG1 to output a sine wave, at 2.375 KHz, having a 12V peak amplitude and a baseline offset of -3 Volts, and switches the output on.

Besides providing standard waveforms, a WG can be downloaded from the computer with up to 2048 samples that define an "arbitrary" waveform: that is, any waveshape you want. These samples can be computed, if the waveform has a mathematical definition; for example, one PILOT is presently in use for testing of radar equipment, and puts out a Gaussian waveform. For a waveform which is not computable (e.g. the waveform from the human heart, seen on ECG's) the samples could be in DATA statements, or retrieved from a disk file which you have previously prepared.

WG1 can be amplitude-modulated, and can accept an external sample-clock, e.g. the 2 MHz crystal clock provided. WG2 can be locked to WG1, with programmable phase shift.

Their beefy output (up to +-20V at +-0.4A) allows the WG's to drive things like transformers, speakers, etc. A WG can even be used as an extra power supply, with amplitude at zero and baseline shift set to the positive or negative value desired. A WG could also drive a transformer/rectifier circuit to provide programmable high-voltage supplies.

Measurements

The PILOT can measure any of the steady-state properties of a voltage or current waveform: amplitude (DC, RMS, average, or peak), frequency, phase difference (relative to a reference input) and resistance.

The PILOT can autorange in amplitude, for all measurements. It can be prompted via the XV or XI command to set its gain appropriately for a given peak signal amplitude, and will either autorange from there or will just stay at that gain, depending whether or not you have auto-ranging on (ARON) or off (AROFF).

Frequency is measured by period-inversion, which gives fast readings even for low frequencies. Input can be either via the floating inputs (VHI/VLO or CURIN/CUROUT), in which case amplitude auto-ranging is available; or via the REFIN, in which case you can select the polarity of the crossover used for counting.

Connection Switching

The three sets of reed relays shown (pins 12-21) are useful for various purposes, typically to select signals for measurement, or to direct waveforms to various points. For example, if we connect ACOM and BCOM both to VHI, and connect VLO to ground, we have an 8-input multiplexer for voltage measurements.

Adapter Support

Any flexible ATE setup normally needs some special add-on hardware, often called a "fixture", to accommodate a given UUT. For the PILOT these are termed "adapters" and are supported via pins 31 to 40. Some UUT's just need mating connectors; even these must be mounted on something, and wired to the PILOT's 40-pin application connector.

Often, you may need extra circuitry. For example, suppose that you are testing a controller board used in a feedback-control system. To allow the UUT to come into a stable state representing normal operation, you need circuitry in the test fixture which simulates the external circuitry to which this board would connect. This circuitry might be nothing more than a passive R-C filter, but it still has to be built somewhere.

Another common requirement is extra switching, to supplement that provided in the PILOT. What is unusual in the PILOT is the ease with which an adaptor can be built, mounted, powered (if active) and controlled from software (if programmable).

The PILOT supports circuitry in adaptors with a bidirectional, bit-serial digital interface capable of 1-to-64-bit transfers; a programmable DC level; and a 30 KHz regulated power supply which can be used to generate a wide variety of special-purpose DC supplies.

Control from the Computer

The PILOT connects via a 3-wire cable to a serial port of the computer: COM1 or COM2.

To make the PILOT do something, the computer sends a command. When the PILOT has data (usually a reading) to report to the computer, it sends back a reply.

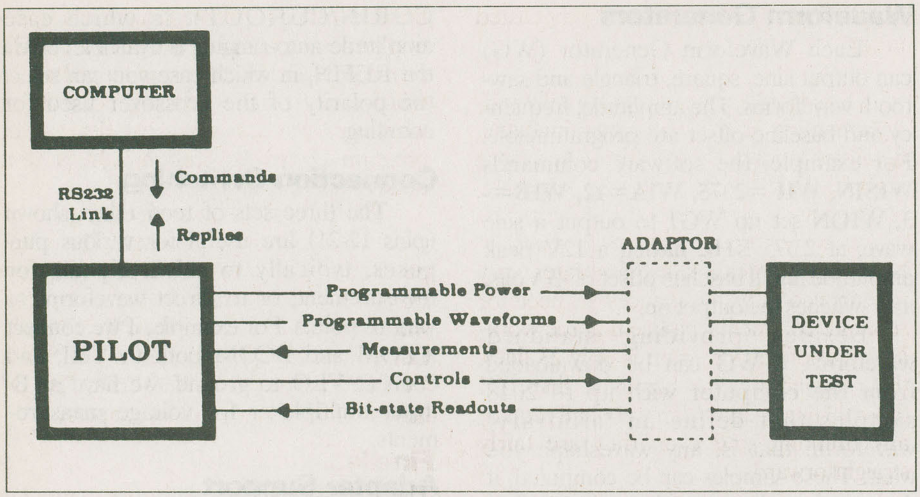


Fig. 1. A block diagram of the PILOT and the Unit Under Test.

In the notation used on the Reference Card, upper-case means "literal": that is, typed in the program just as shown. The arrow brackets contain "placeholders": they get replaced with the quantity indicated. Items in [] brackets are optional.

A command can be a "setting", which asks the PILOT to set up some condition, such as:

P3V = -12 *set Power Supply #3 to -12V*

W1F = 4000 *set frequency of Waveform Gen. #1 to 4000 Hz*

or it can be a "read-request", such as

ARMS *read root-mean-square amplitude*

RIP3 *read current drawn from Power Supply #3*

The PILOT places almost no restrictions on the combining or ordering of commands: commands simply take effect in the order of sending. If an incorrect (e.g. unknown, or out-of-range) command is sent, the PILOT will reject it, report the error and stop.

You can combine several commands into one line, to make program listings more compact and readable. Such a line is termed a command message.

Replies

For every command message it receives, the PILOT sends back to the computer a "reply message", containing character-groups called "replies". There is a reply corresponding to each read- request in the command message.

Suppose that you sent the command message **RIP1, RIP3.**

This says: "Read current drawn from Power Supply #1, and Read current drawn from Power Supply #3".

Suppose now that your UUT draws 250 mA at the positive supply (i.e. from PILOT power supply #1) and 180 mA from the negative supply (power supply #3). The PILOT's reply to that command line would be: 0.25,0.18

What you do with these incoming characters is described later.

Writing Programs

You can write a program in any language to drive the PILOT. QuickBASIC is an excellent language for the purpose, having the simplicity and English-like syntax of BASIC, but with great improvements in structure, editing, debugging facilities, etc.

A test program just has to express, in your chosen computer language, the test procedure which you would have written in English to direct manually-operated testing.

There are two special aspects to the writing of programs to drive ATE (the PILOT or any other form): how do you communicate with the hardware, and how do you debug the program after it is written?

The support software delivered with the PILOT addresses these topics. In particular, there is a "Reply-Handler" routine, which the user can incorporate in each application program. A version is provided for ordinary BASIC and for QuickBASIC.

If you are writing in QuickBASIC, the command line of the previous example would be sent by the statement:

Call Pilot ("P1V= +15,P1C=.30,P3V=-15,P3C=-.30,RIP1,RIP3", Reply())

The Reply Handler does the following:

1. Accepts your command message as a string variable (in quotes, in this example, though commands need not be "literals"; they can be computed or read from variables)

2. Sends this command message to the PILOT via the RS232 port

3. Waits to receive the reply message via the RS232 port

4. Checks each individual reply to see if it is: numeric or an error message. 5. Deposits successive replies in the variable array named in the Call. The measurements you asked for now appear as ordinary numeric variables in BASIC. You can do any of the normal operations with them. In the example, you could test the values of current drawn against limits:

If Reply(1) .055 Then Print "UUT draws too much current from positive supply"

or store them in variables you have named, for later use.

There is a "debug" version of the Reply Handler, which provides powerful debugging tools to help you get your program and adaptor running correctly. It checks your outgoing commands, just as they are checked by the PILOT itself, but with more on-line help.

A Program Example

Suppose that we are manufacturing amplifiers, which we want to test as follows:

1. Turn on the power supplies; check that the amplifier draws between 50 mA and 85 mA from each supply

2. Check that output bias is within 0.15 Volts of ground, as a "health check"

3. Measure the gain, which is nominally 5. Check that it is between 4.9 asnd 5.1

If any of the tested quantities or parameters is out of specification, we want to stop testing and display a message on the screen. A QuickBASIC program to implement this procedure using the PILOT might look like the listing below.

Program to test the Type 2 Amplifier

Adaptor connections to Unit Under Test (UUT):

+Supply: PPS1, -Supply: PPS3, Input: WG1OUT, Output: VH1, Ground: GND, VLO.

DIM SHARED Reply(1 TO 10)
DECLARE SUB Pilot (A$, B())

TEST #1: Set up power supplies to +-15V limited to 100 mA; measure currents drawn, and check that they are between 50 mA and 85 mA

CALL Pilot("P1V=15, P1C=0.1, P3V=-15, P3C=-0.1, RIP1, RIP3", Reply())

IF Reply(1).05 OR Reply(1).085 OR Reply(2)-.05 OR Reply(2).085 THEN
PRINT "UUT draws incorrect supply current"
PRINT "Current from + supply = "; 1000 * Reply(1); " mA"
PRINT "Current from - supply = "; 1000 * Reply(2); " mA"

STOP
END IF

Other tests in the program written in a similar manner could check output bias voltage, AC voltage gain, and many other parameters.

(Note: reply handler subroutine is supplied on the PILOT disk; it is not listed here)

This simple program is virtually self-documenting in the comments, including details of hardware connections. In a more complex case, there would be a schematic of the adaptor, showing the connections and whatever extra circuits were required. Note that QuickBASIC generates very readable code, which reduces the need for separate comments. Notice that the working code of this program is only 23 lines, the remainder being comment lines. Of those 23 lines of code, only about 8 require any thinking, and even they are fairly straightforward.

RS232 Advantages

The compact size and handy RS232 interface of the PILOT allow the use of computer-controlled testing in some rather unique ways. Using a lap-top computer driving a PILOT, you can make a fieldable ATE system, since the PILOT can run from unregulated low- voltage DC power. Lap-top computers don't come with the 488 interface, and have no internal slots where one can be installed.

Even within the workplace, there is great flexibility. To set up testing, you just need any PC/XT/AT computer (no need to put a special interface board in it) and a small area of table-top. When you have finished testing (e.g. doing incoming inspection on some transformers), put the PILOT on the shelf and let the computer go back to word-processing, inventory control, or whatever it was doing. You can develop the program for an application right at your desk, or at home for that matter.

The PILOT is compact enough to be used on production benches. The computer can be remote (this is helped by the simple 3-wire interface to the computer, which is opto-isolated at the PILOT end). Control and display functions such as a "NEXT" button and "GOOD", "BAD" lamps can be included in an adaptor.

Finally...

The PILOT will run with any computer which has an RS232 port, but in practical terms almost nobody uses anything but an IBM-type PC or XT or AT, or clone. Accordingly, the PILOT's support software is written for these computers.

The low cost of the PILOT is due to most functions being in EPROM firmware rather than hardware, to the hardware sharing several functions, to automatic calibration, and to the RS232 port rather than the more complex 488-type.

Further Information on the PILOT is available from the manufacturer, Fernbank Electronic Systems, Box 850, Stittsville, Ontario K0A 3G0, (613) 831-0761. ■

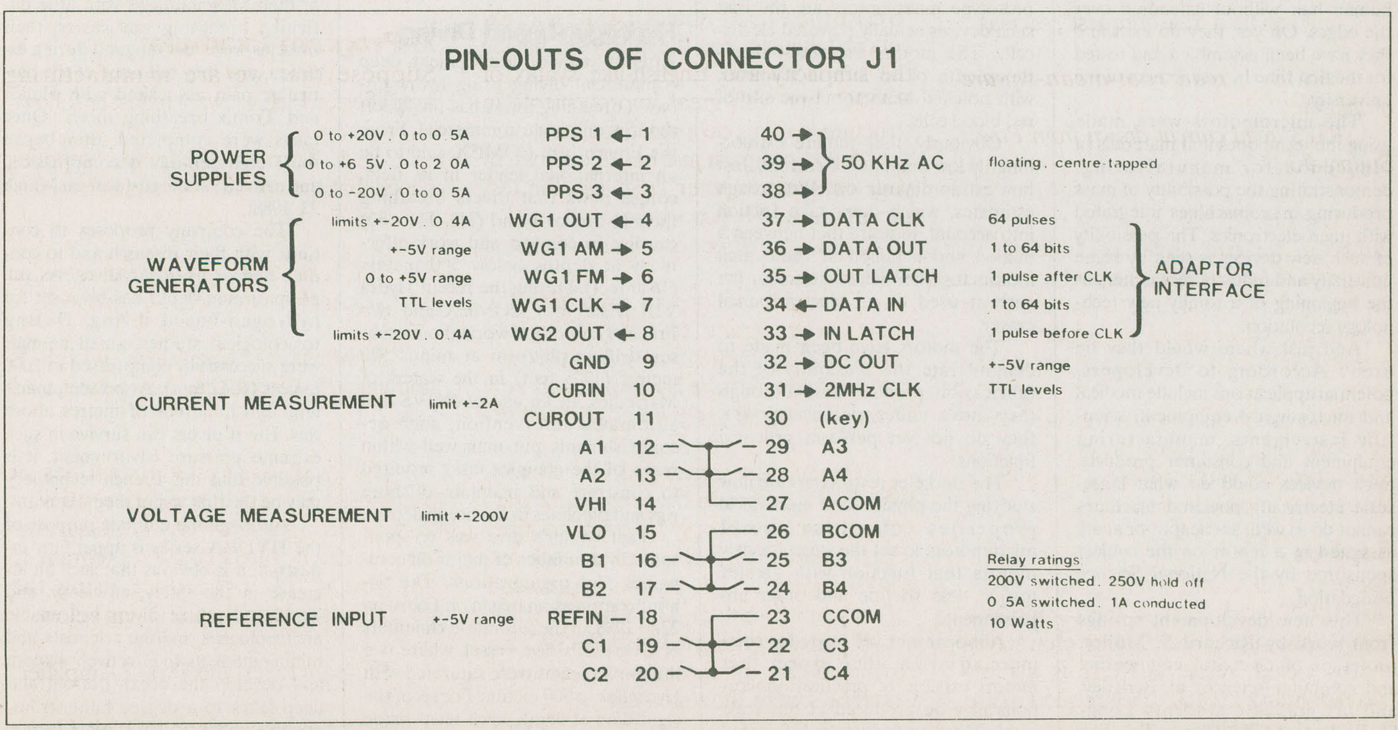
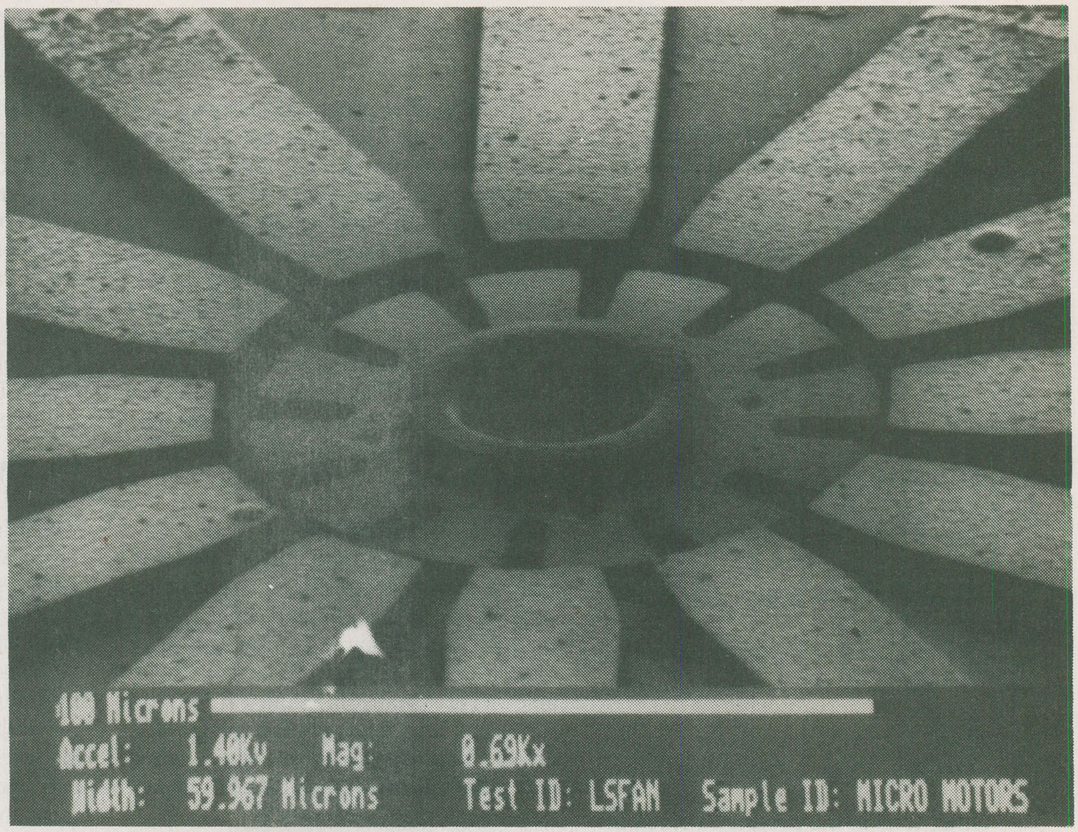


Fig. 2. The connections between the PILOT and the Unit Under Test, and the functions provided; these are explained in detail in the text.

THE SCIENTISTS TELL ME

DAVID P. DEMPSTER



Tiny Motors, Big Potential

First there is bantam, followed by tiny, next comes little, but at the University of California, Berkeley, they are really into miniatures – the miniatures are electrically powered motors so small they could rest on a human hair without extending over the edges. Oh yes, they do exist and they have been assembled and tested for the first time by researchers of the university.

The micromotors were made using the techniques and materials of semiconductor manufacturing, demonstrating the possibility of mass producing micromachines integrated with microelectronics. The possibility of such new devices is seen by some university and industry researchers as the beginning of a totally new technology revolution.

And just where would they be used? According to developers, potential applications include medical and microsurgical equipment, scientific instruments, manufacturing equipment and consumer products. Such devices could do what large-scale electrically powered machines cannot do as well, as cheaply, or at all, as stated in a report on the subject sponsored by the National Science Foundation.

This new development springs from work by Richard S. Muller, professor of electrical engineering and computer sciences at Berkeley, and his graduate students Long-Sheng Fan and Yu-Chong Tai. The electrically powered motors produced by the Berkeley researchers follow successes last year using the same technology to produce microscopic cranks, gears, springs, sliding parts and other devices capable of mechanical movement. The new prototype micromotors are the first such devices actually powered electrically. The motors are about three-thousandth of an inch in diameter, with notched teeth about the size of red blood cells.

Obviously, they require extraordinarily low amounts of current. Just how extraordinarily low? Well, rough estimates, which don't take friction into account, indicate that between a million and a billion of these mini motors together would consumer the current used by an electric pencil eraser.

The motors have been made to demonstrate the feasibility of the fabrication process, and although they move under electrical power, they do not yet perform practical functions.

The Berkeley researchers are now studying the physical and mechanical properties of these novel micromotors to set the stage for new motors that function with greater torque, less friction and other improvements.

Although not yet ready for commercialization, they expect that motors capable of practical applications may be produced at this scale within the next few years. Integrated with microelectronics, micromachines could be employed as miniature assembly line tools, or as new instruments for intricate surgery and delicate laboratory manipulation, capable of tasks unimaginable with today's mechanical instruments.

Hydrogen-based Diving

After 10 years of development, deep commercial diving using hydrogen-based breathing mixes has finally left the labs and gone commercial. From the French firm COMEX, said to be an international leader in its field, comes news that divers breathing their Hydreliox blend (H2- He - 02) can live in comfort and work effectively at depths below 500 meters (1640 feet). During the recent Hydra VIII trials, four COMEX and two French Navy divers worked on a sub-sea drilling platform at minus 520 meters (1705 feet) in the waters of Marseilles. In an age of ROVS and automated intervention, such accomplishments put man well within reach of the complex tasks required to construct and maintain offshore rigs and pipelines in the ocean depths.

Last winter's dive was co-sponsored by a number of major oil companies and organizations. The 94-hour compression began on February 22nd 1988, in the saturation chambers of COMEX's dive vessel, where two three-man teams were saturated with Hydreliox to 500 meters. For six of the eight days at depth, each team made one working dive per day to a maximum depth of 531 meters (1742 feet). Their tasks were varied, including such things as equipment handling, metrology, and pipeline connections.

How did they perform? It is reported that they were able to work at their assigned tasks with little difficulty; breathing was easier, their muscles were less fatigued during exertion, and they felt none of the particular pain associated with Heliox and Trimix breathing mixes. Once tasks were completed, they began their eighteen-day decompression, and arrived "at the surface" on March 23, 1988.

The company proposes to continue with their research and to conduct deeper hydrogen dives. As yet, no maximum depth has been set for hydrogen-based diving. During toxicological studies, small animals were successfully compressed to 2000 metres (6562 feet). At present, man's limit lies hundreds of metres above this. But if divers can survive in such extreme pressure environment, it is possible that this French technology may be the first to put them there.

Although the ultimate purpose of the HYDRA series is apparently industrial, it is obvious that such an increase in the safety, efficiency, and working depth of divers will enable archaeologists, marine scientists and mining interests to effectively explore and develop the ocean bottom and deep lakes to a degree hitherto impossible only a few short years ago.

A 'Buggy' Solution to Pollution

At the University of California, Irvine, Dr. Betty Olson, professor of social ecology, has developed a new solution to environmental pollution. She says it might best be described as a neighbourhood clean-up project for microbes inhabiting polluted sites.

Olson has found a way to identify and amplify specific pollutant-degrading genes inherent in these naturally occurring organisms, causing them to "eat up" toxins quickly, reliably and safely.

The US $1.7 million, three-year study is funded by the Electric Power Research Institute (EPRI), the research and development arm of the electric utilities industry.

"New advances in biotechnology such as DNA probes that allow us to look at the actual genetic make-up of individual organisms have allowed us to discover how bacteria populations adapt genetically to survive in polluted sites," said Olson.

"As a result of my research in this area, I realized that if entire communities of organisms can change to adapt to pollutants, they might instead be genetically manipulated to degrade them."

She added that unlike proposed techniques involving genetically engineered organisms (GEMs), which have met with public concern about the possibility of introducing potentially harmful organisms into the environment, genetic manipulation of existing organisms poses no such threat and is more reliable.

The first two years of the study will be spent conducting lab tests to determine the genetic pollutant-degrading potential of various organisms and methods of amplifying those genes. Amplification techniques include the introduction of various chemical and nutritional stimulants that cause the genes to "turn on."

"The beauty of this method is that we can just as easily turn the genes 'off' once the pollutant has been degraded, returning the bacterial population back to its normal state," said Olson.

Year three of the study will involve field testing at various locations selected by Olson and EPRI. "EPRI is primarily concerned with pollution from petroleum products, including potentially carcinogenic waste resulting from the manufacture of gas from coal and oil that dates back to the early 1900s, before natural gas was put to use," said Olson.

"At present, the only way to clean up these polluted sites is transportation and/or incineration, which could cost anywhere from US $100 million to US $300 million per site. Genetic manipulation techniques could see the same job done for US $50 million per site.

Olson's method also could be applied to waste water treatment, offshore oil spills and chemical spills.

Nuclear Power without Radioactivity

Commercial fusion energy may be years away, but a University of Illinois nuclear engineering professor already has plans for advanced fusion reactors that produce little or no radiation when the fusion fuels react.

George Miley believes it is possible to "reduce the neutron production in fusion reactors to an insignificant level." These "aneutronic" reactors are now being studied by researchers at the U. of I. and other university and national laboratories.

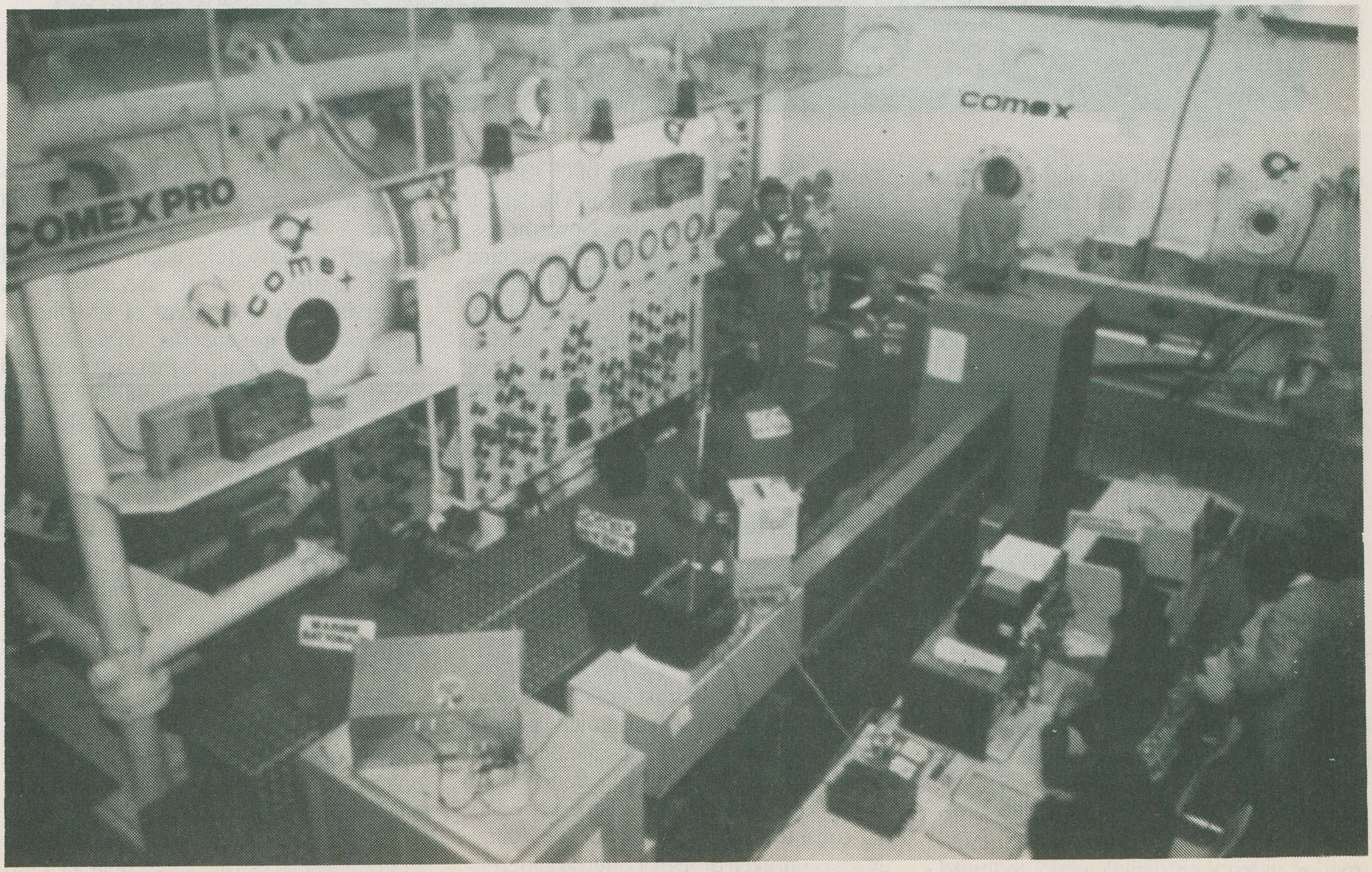
In fission reactors, the atomic nucleus is split to produce energy; however, in fusion, two atomic nuclei are combined to produce energy from a nucleus of greater mass. Both, however, produce radioactive neutrons.

Aneutronic reactors would solve that problem, and MIley is convinced that they are feasible. "For years, man has dreamed of having a miniature sun here on Earth as his own fusion power plant," Miley said. "The reward would be not only an infinite power source for uses here, such as electrical production, but also as a power source for deep space missions."

Conventional fusion energy uses as fuel deuterium and tritium, both mildly radioactive. Aneutronic fusion could use deuterium the helium-3, whose reaction would produce charged particles and few neutrons. Unfortunately, there is a complication — helium-3 is not plentiful on Earth. "It is, however, plentiful on Jupiter, or we could mine the moon for large quantities of helium-3," Miley said. Space missions could use the moon and Jupiter as fusion fuel "filling stations," he said.

A different approach would use hydrogen and boron-3 to fuel the fusion reaction. "Both fuels are readily available on Earth, providing an almost infinite fuel supply, and neither contains radioactive elements," Miley said. "It seems like an ideal future energy source both on Earth and in space."

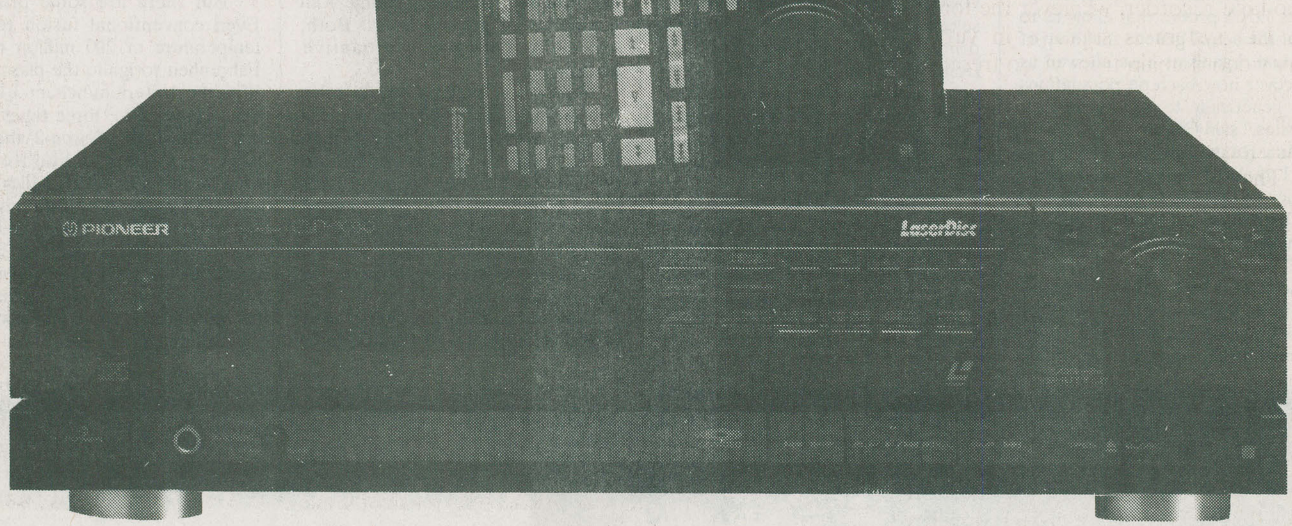
But there are some problems. Even conventional fusion requires temperature of 200 million degrees Fahrenheit to ignite the plasma fuel. With the deuterium/helium-3, the fuel would have to be three times as hot and for hydrogen/boron-2, the numbers then jump a hundredfold. Despite these problems, Miley is convinced that aneutronic fusion is not so far away. "It's like learning to fly," he said. "the leap from the Wright Brothers to flight to jet planes was not long; the leap from conventional fusion will be a short one also. Now that's faith. ■



Pioneer Laserdisc CLD-3030

The laserdisc, overshadowed by the VCR, remains one of the finest home video sources.

TIMOTHY PALMER-BENSON



If you haven't seen the high quality tv picture that can be had from a Laserdisc, you are in for a real treat. This is without a doubt, one of the finest home video sources available to the consumer. Noiseless picture scan, 425-line horizontal resolution and video S/N of 46dB are hard to beat. Add the ability to play back compact disc CD singles (CDs), compact discs with video (CD-Vs) and Laservision Discs (LDs) in one unit and you have what should be a highly attractive product.

Unfortunately, the remarkable capabilities of Pioneer's CLD-3030 cannot be appreciated at the moment by many Canadians. Although there are plenty of CDs around, this is not the case for LDs. The sixty minutes per side offered by the silver LD is not the sort of thing carried by your local video store; only if you reside in a big urban centre can you hope to find one. The situation is even worse when it comes to the golden coloured CD-V discs which contain about five minutes of full motion video with digital audio, followed by an additional 20- minutes of CD-standard digital sound; they just can't be had in this country as far as I know. Nevertheless, I am convinced that eventually, a machine such as this one will be in many Canadian homes mainly because of the high quality audio and video it can offer for movies. There is already a huge library of more than 2,000 LD titles; everything from the latest movies to live opera recordings is available and many of these releases offer CD quality digital Dolby surround sound.

Development

The laserdisc has had a difficult history. First developed by Philips and MCA in 1973 as a first rate video playback medium, it did not appear as a marketable product until 1979. The product was called "discovision." It was the first optical disc format available to the consumer. Unfortunately, by this time, the format had been overshadowed by the introduction of Beta in 1975 and VHS in 1977. Tape provided the consumer with a means of recording; discovision, even though it offered superior video quality, did not. Now discovision is being rediscovered, albeit under a different name — Laserdisc — by those fortunate enough to have televisions capable of reproducing its impressive resolution. Laservision uses a system of FM modulated pits that are encoded on a disc. Unlike CD that contain pits that are translated eventually into binary digital audio, the video information is stored in analog FM form on the disc. The system requires a bandwidth of almost 18MHz. When a laser pickup reads an LD disc, the pits are directly decoded into two FM subcarriers as well a video subcarrier. Two FM subcarriers two channels of analog audio and the third carries the video information. (The analog audio is usually encoded with CX noise reduction developed by CBS). The system has such a large bandwidth that it has been possible to incorporate a digital sound track as well as an analog one in the botton 2MHz of its FM bandwidth, but only for the NTSC system.

Of course, the larger bandwidth of the LD requires more disc space than a CD so

the maximum play times are proportionately smaller. A 12-inch laser disc in the CAV (standard play format) can play 30 minutes per side. The extended play disc, called a CLV, can play a maximum of one hour per side. CLV discs don't offer as much flexibility in programming and it is not possible to select a single frame — the reason why this player captures a field digitally for a freeze frame effect. On the other hand, CLVs are the only realistic answer for movies. Turning over the disc every 30 minutes would be too much.

Although you can't record on a LD and they must be turned over at least every 60 minutes they do offer broadcast quality video that is far superior to any consumer video tape recorder, whatever the format. The LD system is superior in virtually every video domain from video frequency response to colour accuracy and stairstep linearity. It's a professional system with professional quality.

The LD-3030 is packed with features to entice a first time buyer. Picture postcard still frames is what LaseverVision is especially well-known for, but this player also offers special effects that are truly amazing. Pioneer uses an 8-bit sampling RAM with one megabyte memory to provide a number of trick plays and to get around the fact that extended play discs don't offer frame by frame analysis. For example, one can obtain a still frame — actually one field — while the audio continues. The screen can be divided up into a mosaic pattern made up of after images of the moving picture. When a video disc ends, the last frame is held on the screen until the next side begins. Strobe motion is available at seven speeds.

Basic front panel transport controls include play, still, skip forward or back and player drawer open and close. A large knob on the right hand side, called a "Jog Dial" is used to advance or reverse a picture frame by frame, either at half normal speed or at twice normal speed. A concentric control around the Jog Dial, called a "Shuttle Ring" is used also to vary playback speed. It is possible to set picture playback at twice, five and 10-times normal rate in either forward or reverse modes. In the purely audio domain, the control can be used also with CDs to skip through tracks with audible cueing.

A "Contents Calendar" that lights up as soon as a disc is inserted shows how many "chapters" there are on a video disc and automatically detects if the disc has analog or digital sound. The unit will display numbered CD tracks up to a maximum of 19 and these tracks can be programmed. Playback of a higher numbered track cannot be programmed and is not displayed although the machine will play higher numbered tracks after it has gone through the 19th one. The remaining front panel controls deal with things like strobe motion, programming, one shot memory and time display. These controls, as well as others, are duplicated on a fully featured remote control.

Rear panel outputs include two for video and three for audio. A modulated VHF signal — either channel 3 or 4 — can be obtained via an "F" connector or one can use a single RCA jack for carrying a composite signal to a video monitor. On the audio side, a direct optical digital output is provided for connection to an amplifier with its own D/A converters or one can chose the player's own digital/analog outputs. These outputs provide

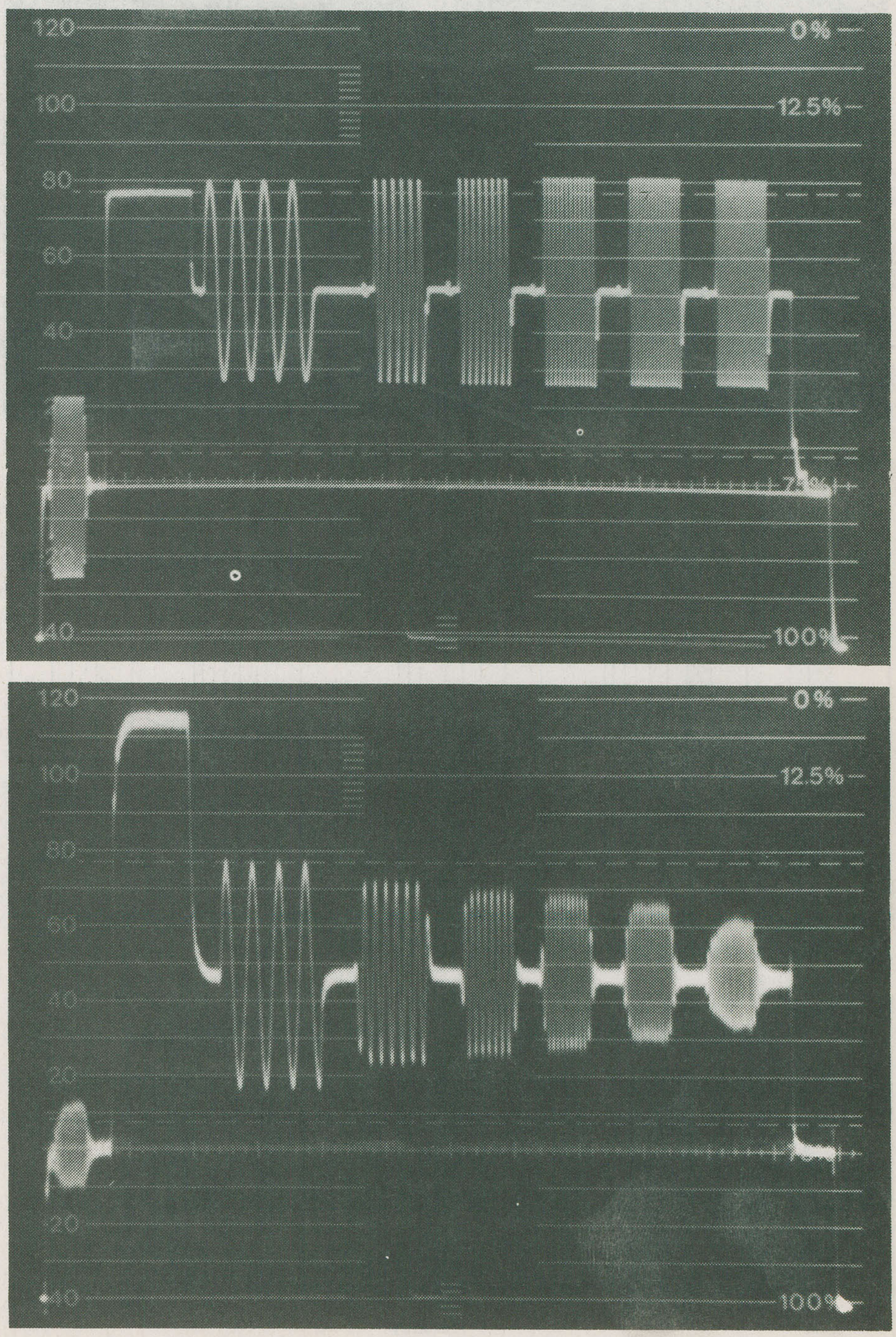


Fig. 1a (top). The multiburst test from the waveform generator, and 1b (bottom), the output from the Pioneer CLD-30330.

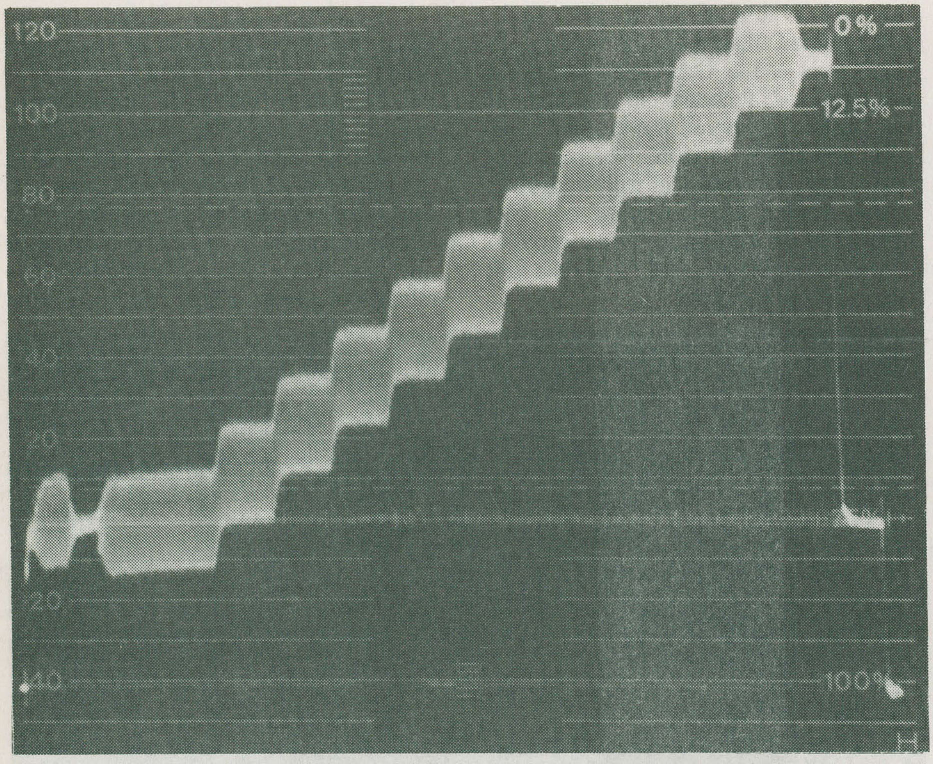


Fig. 2. Stairstep linearity from the CLD-3030 using a test disc.

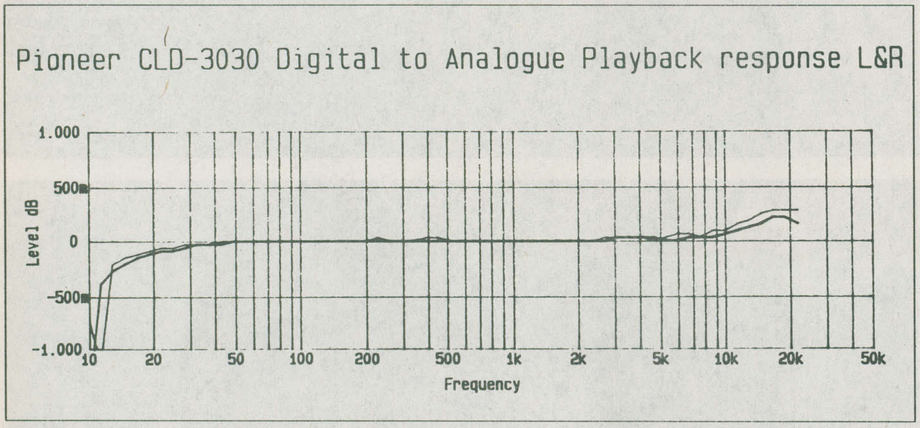


Fig. 3. Digital to analog playback response of the CLD-3030.

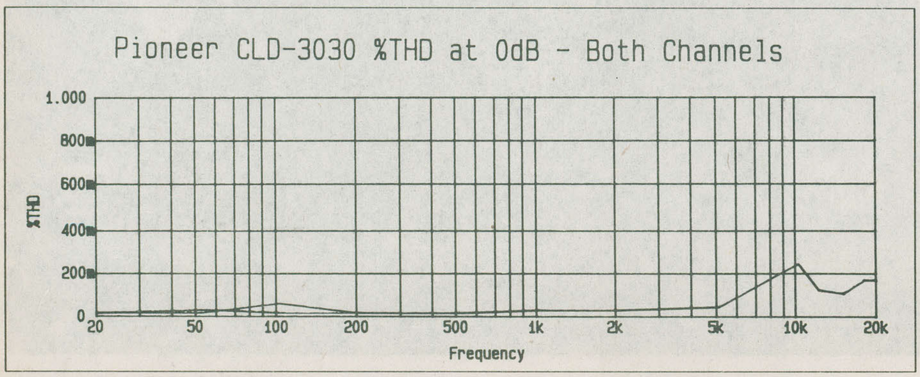


Fig. 4. Percentage Total Harmonic Distortion at 0dB, both channels.

digitally-decoded audio when it is present on a disc. If the disc has only analog tracks then this is what comes out of these jacks. For some strange reason there is a second set of output jacks, dedicated to outputting just the analog tracks of a disc. Their presence seems unnecessary because the front panel controls allow the selection of either the digital or analog audio out of the other set of jacks.

As the format promises, video performance is exemplary. Fig.1a shows a multi-burst taken directly from an NTSC generator. Fig 1b shows the multi-burst as played back from a CD-V test disc. As you can see, there is very little loss in overall video frequency response. It extends all the way out to 4.2 MHz, proof of the player's extremely high resolution. Fig.2 shows the unit's reproduction of a stairstep, and again this is exceptional for a consumer machine.

The performance of the CLD-3030's audio section is just as impressive. The unit incorporates a 4-times oversampling digital filter. Fig 3 shows frequency response for both channels. Response is within 0.5dB from 20Hz to 20kHz. At 1kHz, the 0dB signal from the CBS CD-1 test disc produced 2.09 volts in both channels. The player's signal to noise ratio measured 99.6 dB unweighted on the left channel and 99.9dB on the right. S/N ratios, A-weighted were even better of course, measuring 105.3dB for the left channel and 105.6dB for the right. De-emphasis error was -0.3% on both channels. Channel separation checked out at 95.4dB in reference to a 0dB 1kHz signal. THD is well below 0.2% except at 10kHz as can be seen in fig.4 which is a plot of %THD + N at 0dB from 20Hz to 20kHz.

While the control facilities for playing compact discs aren't as good as a regular CD player, the digital sound quality is first rate. In my judgement it would be necessary to pay upwards of $800 to get a CD player that sounds better than the CLD-3030. As for the video quality, I need hardly say more. It is simply the best I've seen that's available to the consumer. When you couple this player with the appropriate equipment such as a big screen TV and a Dolby Pro-Logic surround sound system and then put on a movie like "Top Gun" I'll guarantee that you'll be blown away. It came as no surprise to me that at this year's consumer electronics show in Las Vegas many of the video booths were using this system. The suggested list price for the CLD-3030 is $2500.00 Canadian. ■

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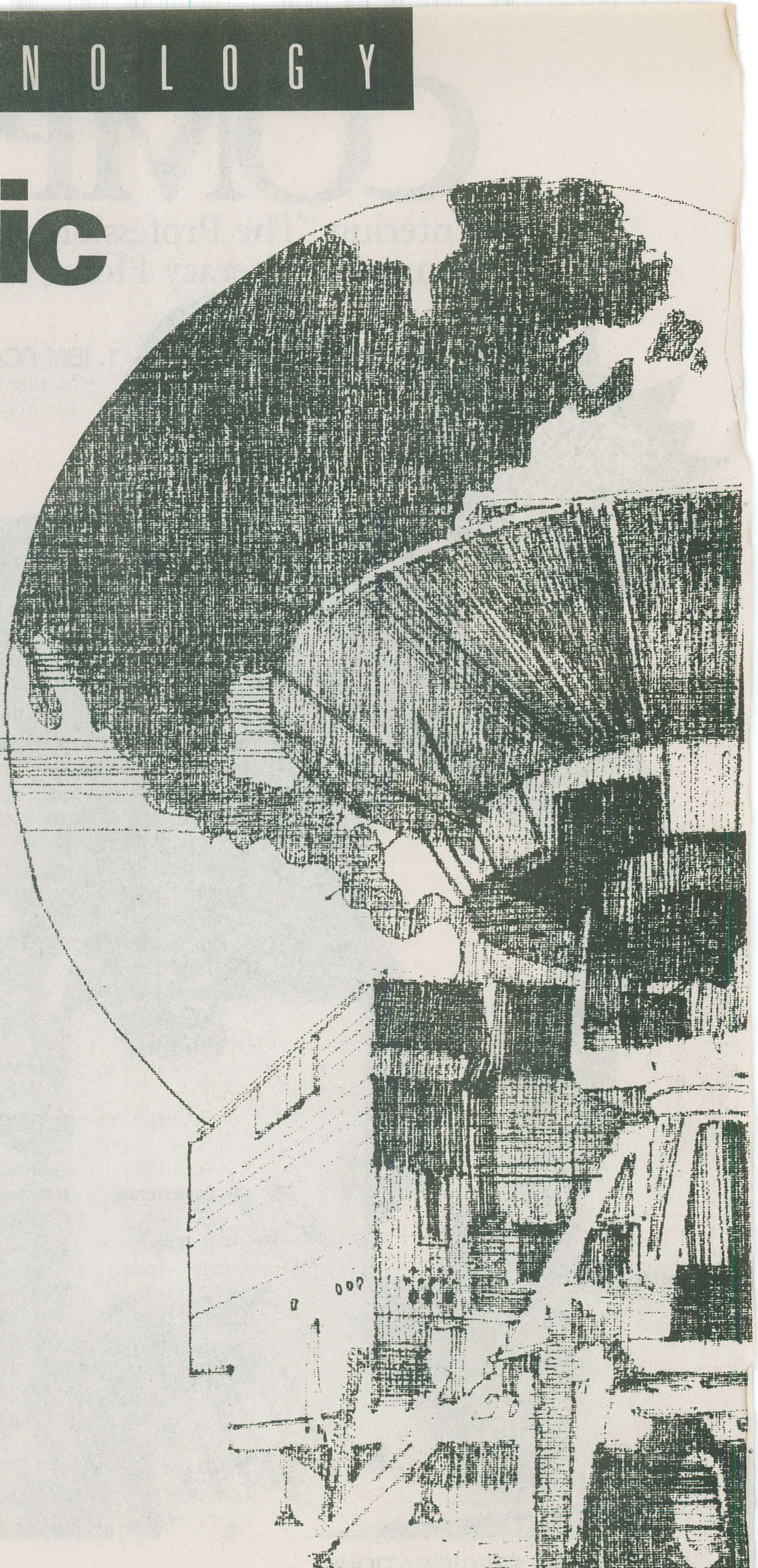
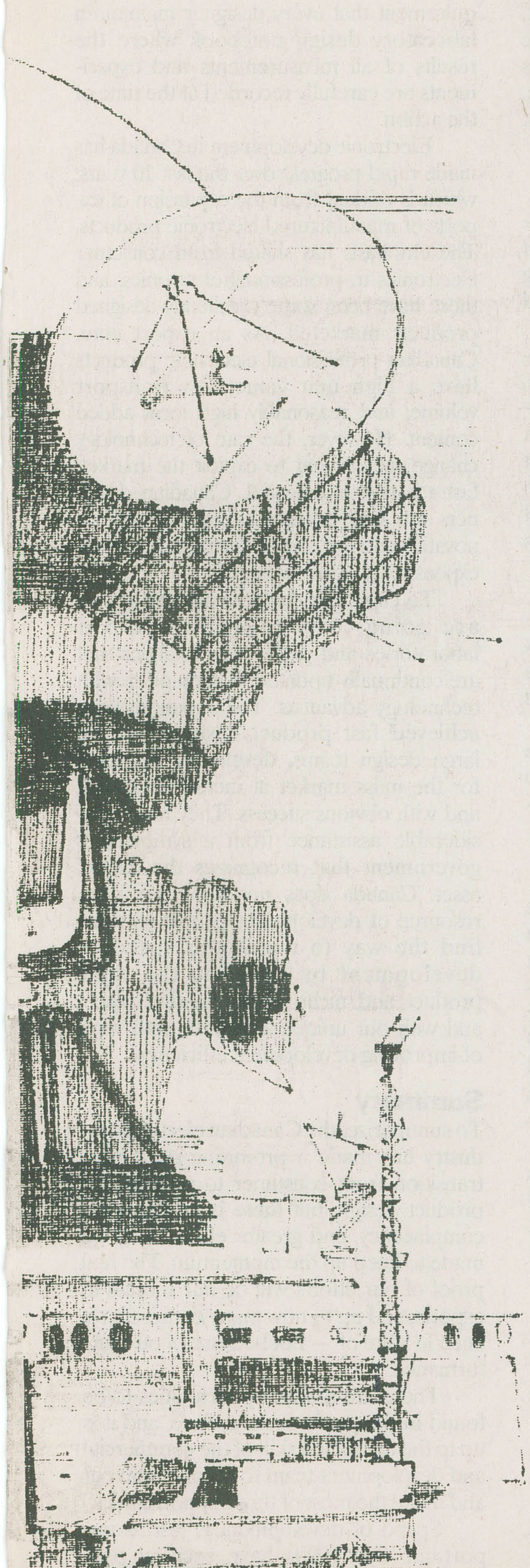
Electronic Design for the 90s

Keeping Canada competitive in world markets.

DR. H. VIRANI





If we are to maintain a place in the world scene of electronic development in the 1990s, it is essential that we take a professional approach to design, with emphasis on quality, efficiency, and an understanding of the consumer wants. The increasing acceleration in electronic development which I have come to accept during nearly 23 years of involvement in electronic design will continue, and the increasing complexity will require a streamlining of the development process if the product is not to be outdated before it gets into production. The axiom: the right products, at the right time, at the right price, with the right quality will become even more the requirement for success.

Speed of development, from product concept to manufactured article will be the essence of a successful design. Except for very simple products, the day of the individual designer working in isolation in his "back room" laboratory has long gone, and a motivated project team, totally committed to the product, time bound and fully aware of costs and cost price, is the modern formula for success.

I have come to the conclusion that we must aim to at least halve the present development and production preparation time, and with our limited main power resources, the project team approach with the right development equipment, is the way most likely to succeed in the future.

A project team will need to encompass skilled input from:

1. Market research (commercial/technical)
2. Circuit design (electronic hardware)
3. Mechanical design
4. Industrial design (hardware)
5. System design (software)
6. Test design (hardware-software)
7. Production engineering (manufacturing)
8. Quality engineering (reliability, safety)
9. Service design (service information, ease of service)
10. Project administration (planning budget control, documentation).

Every one involved in development in Canada will agree that finding development people with training and experience and the right attitude to design is extremely difficult.

The small dedicated project team, well trained, with modern time saving development equipment, and backed by a production unit and the material supply organization that is geared to fast reaction is the alternative most likely to succeed. Production preparation and material supply are subjects in their own right requiring separate treatment, so I must confine my remarks to the development sphere. Now let us look briefly of these aspects of the project and consider the requirements for a successful product in the future.

Market research

A success product must first of all satisfy a need in the market place and secondly it must be profitable to those who manufacture and make it. For the most part, such products require a careful survey of needs, the size of the market, and what market will pay for the product. Imagination and forward thinking are essential ingredients in finding the right product.

Very often a team brainstorming session, in which the team retires to some retreat where there are no interruptions and just lets their thoughts flow, can shorten the development process considerably. All ideas must be recorded for follow up and assessment of their feasibility.

A development programme must then be drawn up indicating possible critical paths and times.

Circuit design

The product design will usually be centred around the electronic circuit design, and the circuit designer need to be aware of the latest technology and components. He will need to have available skilled design technician backup to build up prototypes and equipment for circuit analysis and performance evaluation, and from this activity a product "concept model" should evolve.

Mechanical design

The mechanical designer who should also be involved in the concept model must now finalize the mechanical aspects of the design. He will need to be well versed on modern materials and their applications, tooling, plastic mould design, and manufacturing techniques.

It is in the field of mechanical design and tooling where some of the greatest improvements in speed of development will be possible. Computer aided design (CAD) leading to computer aided manufacture (CAM) has been a promise for the future for some time. Like the introduction of computers themselves in the 60s, CAD is a bright star on the horizon, but in spite of what the salesman may say the promises are not always fulfilled at the outset. Many systems at present available are not very user- friendly and require specialist operators.

CAD technology is involving quickly and the price is rapidly being reduced, but there are still snags in getting the system that will do the comprehensive job expected and at an acceptable price. There is no doubt, however, that CAD will be one of the essential tools for rapid development of all aspects of mechanical design from PCB layouts and metal piece parts to tooling and plastic mould design.

There will not be time for detailed and time consuming drawings, and the trained mechanical designer with a CAD work station must be able to package the electronic design without putting pen to paper and produce computer data that will enable tooling to be completed directly from it.

Industrial design

Industrial design at the concept stage is essential and the product must be ergonomically right, functional, and aesthetically pleasing. Canadian industrial design has made advances over the past ten years and our young designers have come up with some excellent innovative ideas. We will come to have a considerable dependance on them in the future if we are to have our products accepted on world markets. This is one area where consultancy is likely to be beneficial in product design, as it is unlikely that many Canadian electronic design laboratories will be able to employ the full time services of such a designer.

System design

Software will continue to play a major role in system design and process control within the product. Software development is presently one of the most time consuming operations in the design process. The need for software standards as an aid to speeding up software design is apparent. Up-to-date microprocessor development equipment is essential. Again, choosing a development system requires careful consideration.

Test design

Test design both in equipment and procedures has tended to be considered only after the product has reached the engineering model stage. The testing of a complex electronic product requires high speed sophisticated equipment, and the level of test and degree of confidence in the product must be considered at the time the engineering specification is written. Test equipment design must run almost parallel with the product design to ensure that the equipment is ready for the commencement of the trial series of the product. Board test equipment is highly desirable but at present is difficult to justify unless the production series is reasonably large. The investment cost and the cost of software is still very high.

Production engineering

The involvement of the production engineer in the team right at the concept stage will play an important part in getting the product into manufacture quickly, and with the minimum of assembly problems.

Flexible systems for jigs and manufacturing aids will improve preparation times, but the continual improvements to be expected in manufacturing techniques means that the production engineer must be guiding the design team to design with the production techniques in mind that will be available when the product is manufactured.

Quality engineering

The growing awareness that quality is not only built into a product but is also designed in has resulted in the emergence of the quality engineer.

Again early improvements in the design process is essential if delays are to be avoided due to shortcomings of components when production commences.

Service design

The engineer responsible for field service will have an important input at the design stage and has responsibility to ensure that technical service documentation is completed before the product is released for series production. Product reliability will continue to increase and service personnel will not only need greater diagnostic skills but will require comprehensive information to effect repairs efficiently.

Mean Time Between Failure figures running up to decades will mean that field service personnel will no longer be confronted with familiar faults that are easily diagnosed and repaired.

Project Administration

The use of a computer to speed up the processing of costs, development hours, project planning and performance against budget will ensure that the required disciplines are adhered to and fast factual reporting is available.

All product documentation should be on a word — processor with a full range of graphic text available so that rapid up date is possible.

In addition it should be a basic requirement that every designer maintain a laboratory design notebook where the results of all measurements and experiments are carefully recorded at the time of the action.

Electronic development in Canada has made rapid progress over the last 10 years, which is evident from the expansion of exports of manufactured electronic products. The emphasis has shifted from consumer electronics to professional electronics, and there have been some excellently-designed products marketed. As an export item, Canadian professional electronic products have a high unit value, low transport volume, and reasonably high local added content. However, the rate of technology change means that to exploit the market, fast reaction is essential. Canadian designers are well educated, versatile and innovative and the cost of development is not expensive by world standards.

To capitalize on these advantages we are going to need well equipped laboratories and production facilities that are continually updated to keep place with technology advances. The Japanese have achieved fast product development by large design teams, developing products for the mass market at incredible speed, and with obvious success. They have considerable assistance from a sympathetic government that recognizes the export asset. Canada does not have this large resource of development people so must find the way to match this speed of development by choosing the right product and niche in the market place, and with our unique attributes, find ways of improving development efficiency.

Summary

To summarize, the Canadian electronic industry has made a promising start in its transition from consumer to professional product design, but there is no room for complacency, and greater efforts must be made to keep up the momentum. The real proof of our efforts will be our success in exports, and up to now many of these have been in spite of — not because of our performance.

There are always opportunities to be found in the professional sphere, and it is up to the combined skill of the commercial and development team to search them out and make the most of those opportunities.

Speed of development is just as important. The 1990s have exciting possibilities for the Canadian electronics industry if we can anticipate and react to market requirements. ■

Elimination Game

A simple game that illustrates the idea of the vibration sensor.

T.R. de VAUX-BALBIRNIE

The festive party game of "Pass-the-Parcel" has entertained children for generations. In this electronic version, children sit in a circle and pass the parcel from on to another. After some unpredictable time, it buzzes loudly – the child holding it is then "out" and withdraws from the game. Play resumes until only the winner remains.

In the alternative mode, the parcel is activated by vibration. Thus, any child failing to pass it with the greatest of care will activate it. This guarantees a breathing space where harassed parents can relax before resuming the more strenuous activities.

The circuit may be switched to operate by time alone, vibration alone or both modes together.

Circuit Description

The complete circuit is shown in Fig. 1. One half of the dual timer, IC1a, in conjunction with IC2, forms a pseudo-random time generator. This is so called because the times are not really random – they keep repeating but no one will notice.

When the circuit is switched on using S3, IC1a produces a slow stream of pulses from its output (pin 5). The repetition rate depends on the values of preset VR1, resistor R1 and capacitor C1 – VR1 forms the adjustment for this.

These pulses have a large "mark" and a small "space", see Fig. 2a. Transistor TR1 inverts these (a space becomes a marks and vice-versa) so pulses shown in Fig. 2b are obtained at the collector. These pulses are applied to IC2 clock input (pin 14).

IC2 has ten outputs and with the arrival of each pulse, these go high in turn. However, not all ten outputs are connected – the four used ones are outputs 1, 2, 5 and 7 (pins 2, 4, 1 and 6 respectively).

On switching on, output 0 will be high with the IC in the reset condition. Assuming a pulse rate of one every 10 seconds, output 1 will go high after 10 seconds, output 2 after a further 10 seconds, output 5 after a further 30 seconds (since outputs 3 and 4 are missed out) and output 7 after a further 20 seconds. Output 1 will then go high again after a further 40 seconds (since outputs 8, 9, 0 and 1 are missed out).

Diodes D1 to D4 direct a pulse from any high output, via capacitor C3 to transistor TR2 base. This gives a momentary low pulse at the collector which triggers IC1b (S1 disables this section if required). IC1b is connected as a monostable having a time period of one second approximate-

ly. This time depends on the values of preset VR2, resistor R8 and capacitor C5. Preset VR2 can vary the operating time between 0.5 and 2 seconds approximately.

When IC1b is triggered, its output (pin 9) goes high and supplies base current to transistor TR3. This, in turn, operates the audible warning device, WD1 in its collector circuit.

With switch S2 set to the vibration mode and when the "parcel" is moved sufficiently, the sensor contacts close momentarily and IC1b is triggered directly. Switches S1 and S2 can be switched on together if desired so that the circuit triggers in either situation. Note that IC1a and IC1b form two independent sections of the same IC.

Construction

Construction is based on the Veroboard layout shown in Fig. 3. This is made from a piece of 0.1 in. matrix stripboard, size 17 strips X 34 holes.

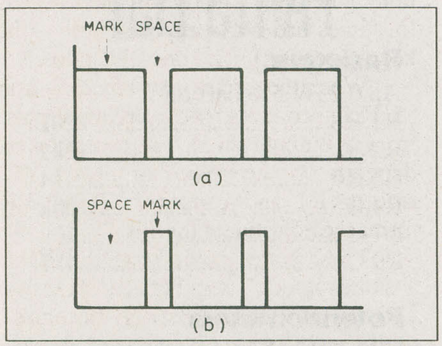


Fig. 2. Output pulses from the timer IC1a (pin 5) and (b) after inversion by TR1.

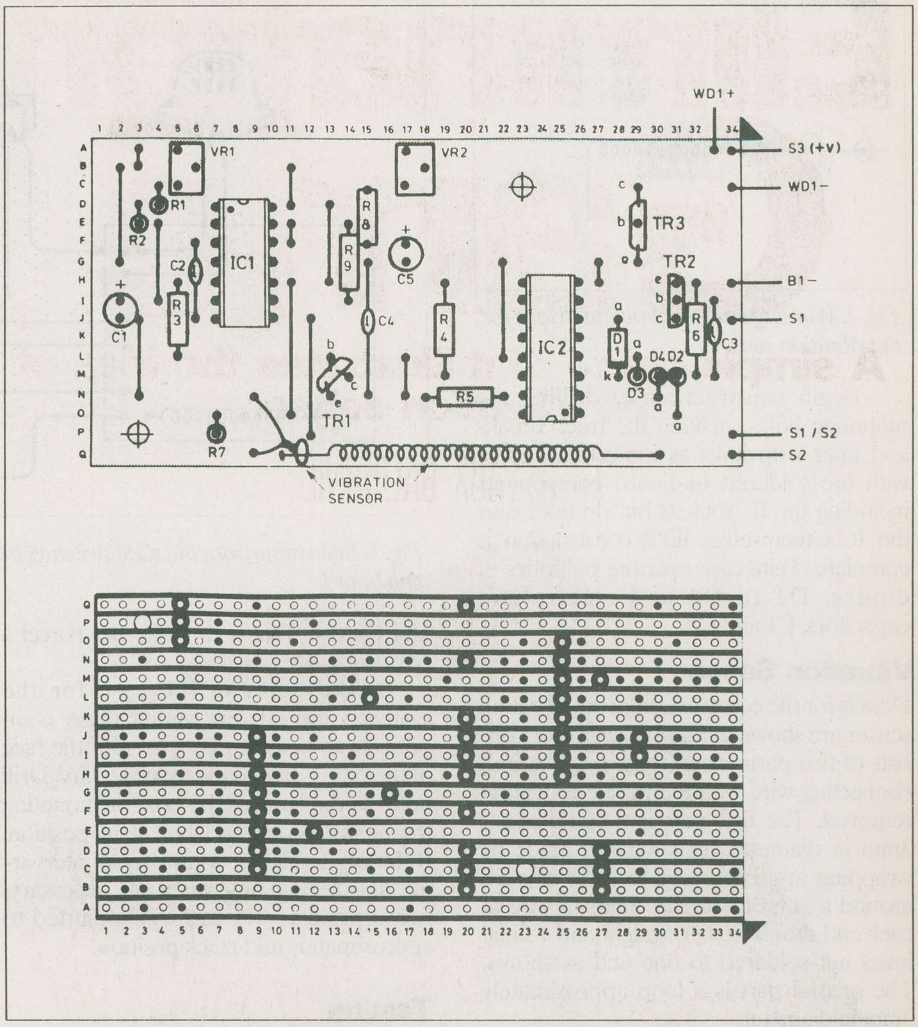


Fig. 3. Stripboard component layout and details of the breaks required in the underside tracks.

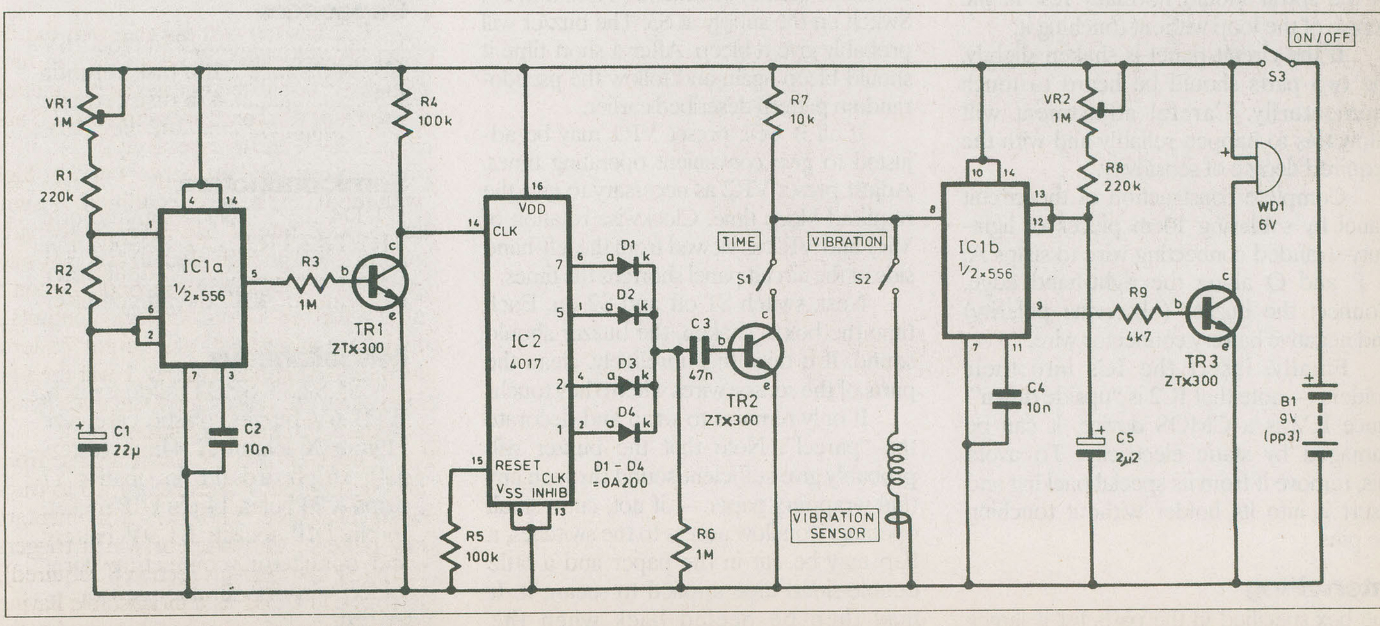


Fig. 1. The complete circuit diagram of the game.

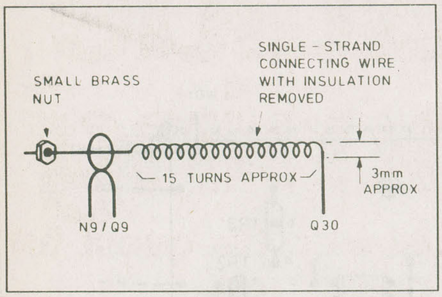


Fig. 4. Winding and construction details for the vibration sensor.

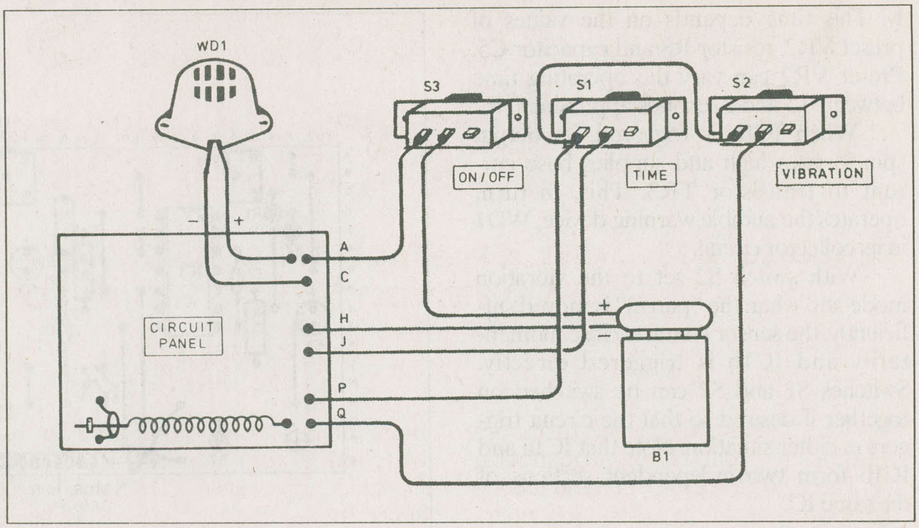


Fig. 5. Interwiring from the slide switches, buzzer and battery to the component side of the circuit board.

Begin construction by drilling the mounting holes, making the track breaks and inter-strip links as indicated. Follow with the soldered on-board components including the IC sockets but do not insert the IC's themselves until construction is complete. Take care over the polarities of diodes, D1 to D4 and electrolytic capacitors, C1 and C5.

Vibration Sensor

Details for the construction of the vibration sensor are shown in Fig. 4. The sensor consists of two parts made from single-strand connecting wire with the plastic insulation removed. The first part is a spiral about 3mm in diameter. This may be made by wrapping approximately 15 turns of wire around a 3mm twist drill. 5mm of wire at each end should be left straight and a small brass nut soldered to one end as shown. The second part is a loop approximately 3mm in diameter.

These parts are soldered to the circuit panel in the positions indicated. The end of the spiral should normally rest in the centre of the loop without touching it.

If the circuit panel is shaken slightly, the two parts should be heard to touch momentarily. Careful adjustment will allow this to happen reliably and with the required degree of sensitivity.

Complete construction of the circuit panel by soldering 10cm pieces of light-duty stranded connecting wire to strips A, J, P and Q along the right-hand edge. Connect the buzzer (observing polarity) and negative battery connector wire.

Finally, insert the ICs into their holders — note that IC2 is "upside down". Since IC2 is a CMOS device, it can be damaged by static electricity. To avoid this, remove it from its special packing and insert it into its holder without touching the pins.

Interwiring

The box specified in the parts list is larger than is really necessary to house the circuit and battery. This is to make the parcel a reasonable size.

Make holes in the case for the switches and buzzer. Mount these components so that they lie level with the face of the box — use spacers if necessary. Drill holes in the base of the box for mounting the circuit board and bolt it in position. Referring to Fid. 5, complete all interwiring shortening any wires as necessary. Leave presets VR1 and VR2 adjusted to approximately mid-track position.

Testing

Connect the battery and secure it to the base of the box using an adhesive fixing pad. Switch S1 (Time) on and S2 (Vibration) off. Switch on the supply at S3. The buzzer will probably give a bleep. After a short time it should bleep again and follow the pseudo-random pattern described earlier.

If all is well, preset VR1 may be adjusted to give convenient operating times. Adjust preset VR2 as necessary to give the required bleep time. Clockwise rotation of VR1 and VR2 as viewed from the left-hand side of the circuit panel shortens the times.

Next, switch S1 off and S2 on. Each time the box is shaken, the buzzer should sound. If it does this unreliably, clean the parts of the sensor wires where they touch.

It only remains to wrap and decorate the "parcel". Note that the buzzer will probably give sufficient sound through any thin wrapping paper — if not, cut a small opening. To allow access to the switches, a flap may be cut in the paper and a little double-sided tape applied to secure it. It may then be peeled back when the switches need to be used. ■

PARTS LIST

Resistors

All 0.25W 5% carbon

R1,R8	220k
R2	2k2
R3,R6	1M
R4,R5	100k
R7	10k
R9	4k7

Potentiometers

VR1,VR2 1M submin. vertical trim

Capacitors

C1	22u elec. 16V
C3,C4	10n disc ceramic
C3	47n disc ceramic
C5	2u2 elec. 16V

Semiconductors

D1-D4	1N914 signal diode
TR1,TR2,TR3	2N3904 *npn*
IC1	556 dual timer
IC2	4017 decade counter

Miscellaneous

S1,S2,S3 SPDT slide switch, WD1 6V buzzer, plastic case, size 119mm X 99mm X 44mm (external), stripboard 0.1 in. matrix 17 strips X 34 holes, 14-pin DIP socket, 16-pin DIP socket; B1 9V battery and connector, connecting wire, solder, wire for vibration sensor — see text.

The Techie's Guide to C Programming

Episode the third, in which Max O'blivion pauses on his quest for the lost function long enough for a quick read.

STEVE RIMMER

This month we're going to have a quick look at C language books. There are quite a lot of them lurking about, and this includes a few pretty dreadful ones. As helpful as I've tried to make this series of articles, a few reference books will do you enormous good. They're great when you're uncertain about syntactical questions concerning C, and, if you have enough of them, you can drop them on cats. This rarely harms the books, but it'll keep the cats off your keyboard in the future.

These books can be found at your local book store. Computers are very trendy, and just about every book store on the planet has a shelf devoted especially to them. If you buy your books at a store wherein the cashiers are particularly stunned, you can often get away with telling them that the prices are in hexadecimal – being computer books – and translate them into the appropriate, lower, decimal prices.

Dead Trees

The quintesstial C manual is *The C Programming Languge* by Brian W. Kernighan and Dennis M. Ritchie, published by Prentice- Hall. These are the two characters originally responsible for the creation of C. This book is often referred to simply as "Kernighan and Ritchie", inasmuch as all C books have pretty similar titles and this sound slicker, like, maybe you knew the dudes personally, y'know.

Being quintessential and all, Kernighan and Ritchie is a difficult read. You should bear in mind that C was originally developed for mainframe computers, and that this book was written before the PC was even a gleam in anyone's eye. It is, however, *the* authoritative reference for the language, and everyone ought to own a copy. It has recently been revised.

Somewhat less quintessential, to the point of obscurity, *C Primer Plus* by Mitchell Waite, Stephen Prata and Donald Martin, published by Sams, is a lot easier to get through, as well as being thicker and more devastating to felines. It's intended for use with PC implementations of C, and it gets into many hardware specific areas of writing specifically for the PC. It's user friendly to the point of being user obsequious, but after a few nights of head banging with C you'll probably need a friend. This is a beginner's book.

For serious C programmers, *The C Toolbox* by William James Hunt, published by Addison-Wesley, will get you into writing code that no one will ever dare even snigger at. It's full of things like sorting algorithms, BTREE code and so on. It's a bit advanced and daunting when you first get started, but it's a good effort later on. This is an experienced programmer's book.

Variations In C by Steve Schustack, published by Microsoft, is very much into Microsoft's compilers. It seems very much like a book written by someone who had a lot of C functions lying about and nothing to do with them. Most of the examples in it are intensely specific, such that nothing in the book is likely to be of any use as it stands. This by no means invalidates *Variations In C*... the approaches are sound and you'll learn a lot from seeing how things are done. The purple type gets to your eyes after a time. This is an intermediate book.

A somewhat less intense work, *Proficient C* by Augie Hansen, also published by Microsoft, is a fairly gentle introduction to C. It uses comprehensible example programs, is readable and clear and doesn't attempt to stun you with the author's blinding insights into the zen of programming. It's a good beginner's book.

One of my favourite books for flinging at cats, *C Programmer's Library* by Jack J. Purdum, Timothy C. Leslie and Alan L. Stegemoller, published by Que, is serious to the point of polyester. It gets into some very specific C code which elegantly solves all sorts of problems you'll probably never come across. It illustrates things like complex device and file control fairly well. I suspect that the examples in it came from a mini or mainframe environment – they're very non-specific, and ignore some of the cruel realities of programming on the PC. This is an experienced programmer's book.

If you can't find Kernighan and Ritchie, a book called *C: A Reference Manual* by Samuel P. Harbison and Guy L. Steele Jr., published by Prentice Hall, is almost as good. It's considerably expanded, with more verbose explanations and examples, and it covers a number of recent changes to C in greater detail. I still prefer Kernighan and Ritchie – once you get into C, it's brevity, like that of the language itself, is easier on your brain. This is a beginner's book.

Finally, *The C Primer* by Les Hancock and Morris Krieger, published by McGraw Hill, is a thin, non-descript little C manual that wouldn't even wound a kitten... much. It's a fairly painless introduction to the language. It doesn't go very far, but it also doesn't drive you into carburetor repair as an alternative to programming. If you don't have to pay a lot for it, it's not a bad beginner's book.

Book of Dreams

This is a tiny fraction of the C books that exist, of course. I've omitted about three times as many that I've read and trashed, and probably three times as many again that I haven't checked out. Once all the cats are dead, there's no way to bring them back for more.

If you seriously want to get into C, I'd suggest popping for at least a few of these. There's nothing like knowing what you're doing to make a job go quicker. ■

Class One Sound Amplifier

A single board, 20W per channel, high quality amplifier with inputs for disk, compact disk, radio, video and tape.

GRAHAM NALTY

With the Class One Sound Amplifier, the standard of construction you can achieve without the use of specialist tools is equal to the very best manufactured amplifiers. The DM20 (Dual Mono 20W) has been designed as a very special project. It is not simply another amplifier project, but designed to be the best that could be produced using today's technology, in terms of value for money, sound quality, presentation and the education value of construction and testing.

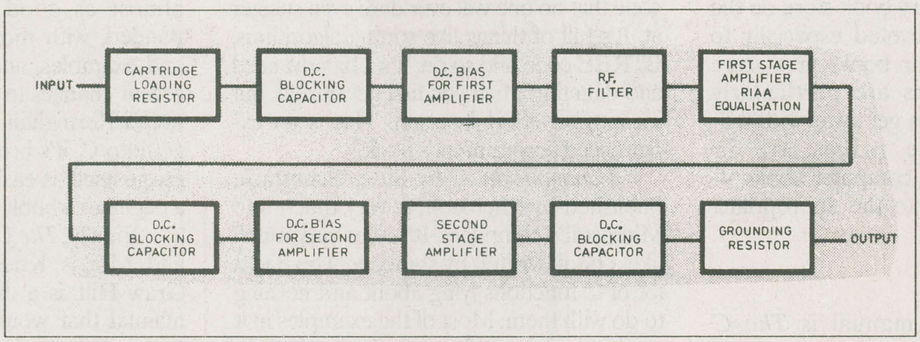


Fig. 1. Block diagram for the preamplifier stages.

Sound Quality

The DM20 has several features which improve its sound quality over amplifiers which the reader might consider comparable.

1. Oversize power transformer, rated at twice the full power output of both channels together.

2. Separate transformer windings, rectifiers and reservoir capacitors for left and right channel for improved stereo performance.

3. Separate rectifiers and reservoir capacitors for low and high current parts of power amplifier and for preamplifier.

4. Large heatsink for low temperature generated distortion as well as reliable operation.

5. T0220 driver transistors for low temperature generated distortion.

6. Cascode circuitry in drive stage of power amplifier for greater linearity and improved high frequency performance.

7. Special two-transistor input stage for improved sound quality (see later explanation).

8. Power amplifier negative feedback AC path taken outside the output capacitor.

9. High quality metal film resistors and plastic film capacitors used extensively.

10. Two stages of power supply filtering for preamp.

11. Special disk circuit designed for good power supply ripple rejection.

12. High quality plated switches used for signal switching.

Educational Value

The DM20 provides excellent opportunities for electronics teaching. The most attractive feature is the high motivation of students to complete it so they can use it. Also the preamp and power amplifier stages have different levels of complexity and can be used on their own for students at different levels.

Students wishing to gain experience of making printed circuit boards will find the preamp section easy for making their

own layout while a single channel of the power amplifier will provide a more exacting challenge for experienced students. A major problem for educational establishments is the cost of purchasing components for a project. Savings can be made by using 5 per cent carbon resistors in place of metal film resistors, and electrolytic capacitors in place of polyester capacitors (provided the correct polarity is observed, but not C3, C4, C103, C104) and substituting the switch system for one four-pole two- way rotary plus a toggle for tape monitor.

Single winding transformers can be used provided one lead is connected to both fused input lines and the other is connected to both non-fused lines. Such measures will reduce the sonic performance of the amplifier but the amplifier will still work. Note: test voltages may be different to those measured using a transformer with separate windings.

The use of separate power supplies for each stage makes testing of the amplifier a more logical process and enhances its value as a training exercise.

Circuit Design

The circuit uses standard components which are easily obtainable. Many readers might be expected to see the latest audio integrated circuits, but there are several good reasons why discrete components are used. Firstly, the use of integrated circuits would require more complex power supplies. Secondly, building the amplifier with integrated circuits would make the project less useful for educational and training purposes. Thirdly, I see no reason why the use of integrated circuits could improve the sound quality.

Tone controls are not included in this design.

Preamp

The preamplifier is a simple but very effective circuit. Its operation is very easy to understand and it contains three stages:

Stage 1: common emitter amplifier using *npn* transistor.

Stage 2: common emitter amplifier using *pnp* transistor.

Stage 3: emitter follower.

All other components are included to enable these three stages to work effectively and a full block diagram is shown in Fig. 1. The preamplifier circuit diagram is shown in Fig. 2.

1. Cartridge loading resistor R1. This has two functions. The first is to set the DC potential of the input side of C1 to ground so that no large transients are generated when a cartridge is connected, and the second is to provide the required resistive load to the cartridge to enable the cartridge to perform at its best. The frequency response of the cartridge will vary with varying load resistance.

2. DC blocking capacitor C1. This allows all audio frequency signals to pass, but blocks DC. This is necessary because the circuit requires different voltages between the input and the base of TR1.

3. DC bias circuit D1, D2, R3, R4.

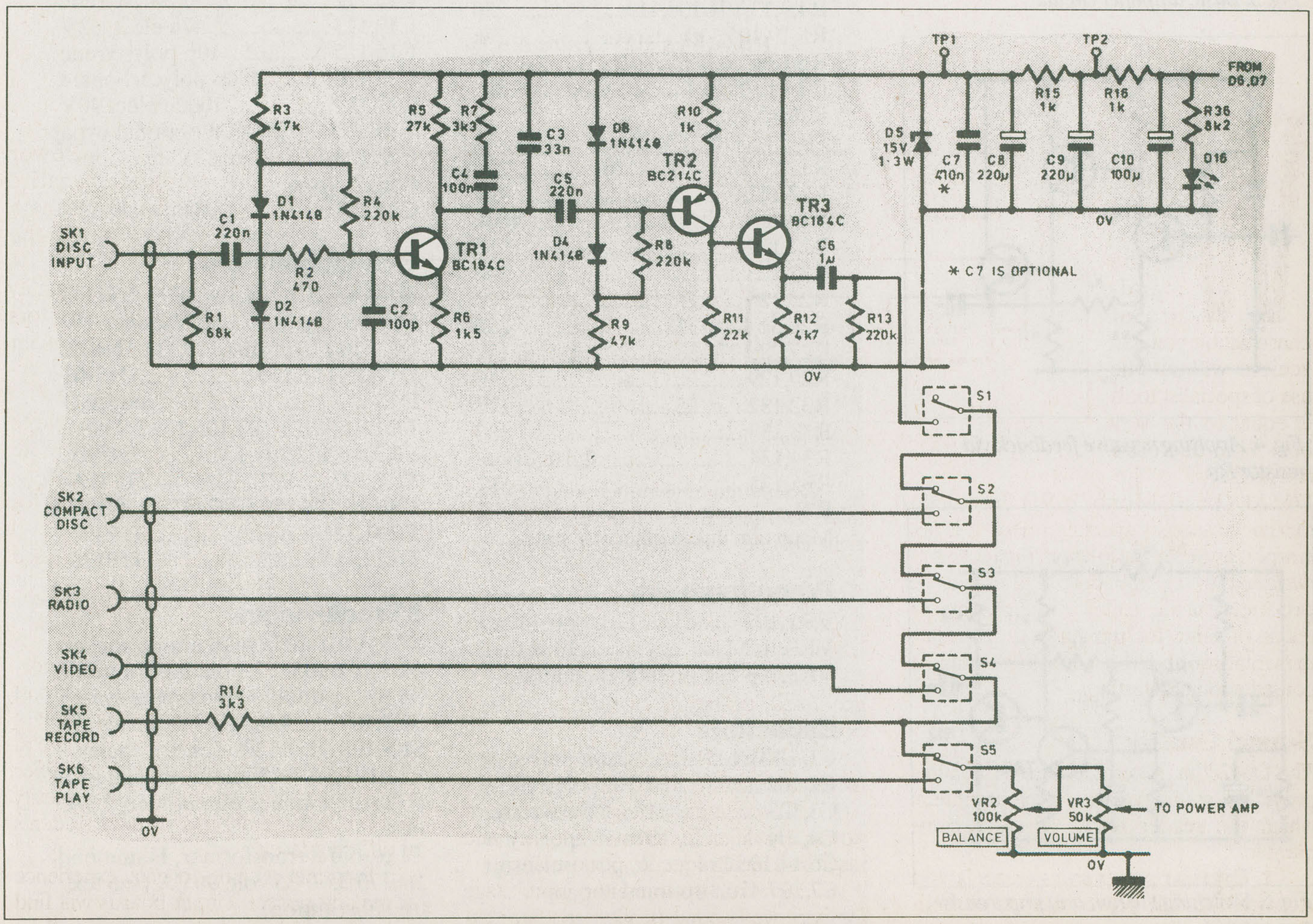


Fig. 2. The schematic for the preamplifier stages, showing inputs for disk, CD, tuner, and tape.

Transistor TR1 requires a DC voltage of around 0.8V to 1.0V to work properly. Diodes D1 and D2 are conducting with a current taken from the supply via R3. This gives a voltage close to 1.2V at the anode of D1. Current flows via R4 to the base of TR1. The product of TR1 base current XR4 gives a voltage of around 0.3V to set the base of TR1 at around 0.9V.

4. Radio frequency filter R2, C2. This prevents any radio frequency signals which see the leads from the cartridge as an aerial being demodulated by TR1.

5. First amplifier stage TR1, R5, R6, R7, C3, C4. The DC current through TR1 is determined by the DC voltage at the base. The base emitter junction will have a volts drop of 0.6V and so the voltage across R6 will be around 0.3V. As the transistor has a high gain, the DC current through R5 will be the same as through R6. A low frequency AC signal at the base of TR1 will be amplified by the ratio R5/R6, but as the frequency of the signal increases the gain will decrease, due to the effects of C3 and C4/R7. This frequency selective circuit provides equalization for records which are recorded at higher level at high frequencies to reduce the overall noise.

6. DC blocking capacitor C5 enables DC potentials to be different at either side while allowing all audio frequency signals to pass.

7. DC bias D3, D4, R8, R9. Operates as in paragraph 3 above, but is referenced to the supply.

8. Second amplifier TR2, R10, R11. Operates as TR1 but in reverse polarity and constant gain at all frequencies.

9. Emitter follower TR3, R12. This reduces the output impedance of the circuit. If this were omitted and a tape deck were connected at the output, the gain of the circuit would be considerably reduced by the effect of the tape input impedance in parallel with R11.

10. DC blocking capacitor C6 prevents

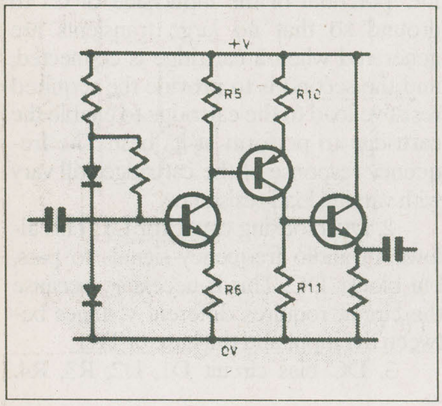


Fig. 3. Basic amplifier circuit.

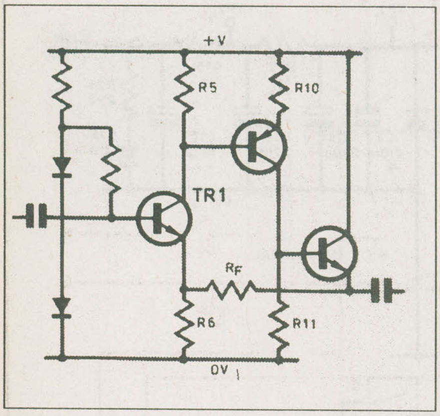


Fig. 4. Applying negative feedback via resistor R_F.

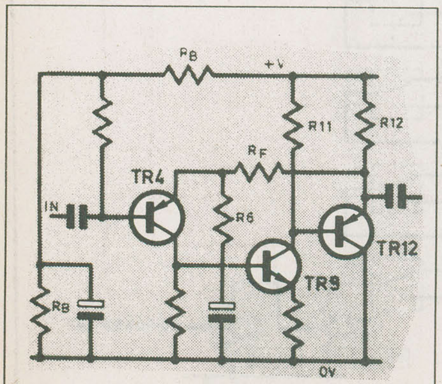


Fig. 5. Switching the npn and pnp transistors around.

PARTS LIST

Resistors

R1,101 .... 68k
R2,102.. 470
R3,9,24,103,104,124 .... 47k
R4,9,13,104,108,113................. 220
R5,19,105,119 .... 27k
R6,106... 1k5
R7,14,107,114 .... 3k3
R10,15,16,17,21,
110,115,116,117,121................... 1k
R11,20,30,111,120,130............. 22k
R12,112 .... 4k7
R18,118 .... 100k
R22,122 ....1M
R23,123 100
R25,125 22
R26,31,126,131......................... 220
R27,28,127,128...............1 ohm 1W
R29,129 10
R32,132 .... 680 1W
R33,133...................................... 330
R34,134....................... 22k carbon
R35,135 .... 47 5W
R36... 8k2
Metal film unless otherwise stated.

Potentiometers

VR1,101 ....1k trimmer
VR2,102 ....100k dual
VR3,103 50k or 100k dual audio

Capacitors

C1,5,101,105 .... 220n polyester
C2,102 .... 100p polystyrene
C3,103 .... 33n 5% polyester
C4,104 .... 100n 5% polyester
C6,14,106,114 .... 1u polyester
C7,107 470n optional bypass
C8,9,108,109 220u elect. 35V
C10,19,21,110,119,121 100u elect. 63V
C11,22,111,122........ 470n polyester
C12,112 .... 220p polystyrene
C13,113 ....47u elect. 63V
C15,115 .... 10p polystyrene
C16,116 ....100n polycarbonate
C17,117................ 1000u elect.40V
C18,20,118,120 470n optional bypass
C23,123 100u elect.63V elect. optional bypass
C24,124 ....3300u elect.63V

Semiconductors

D1-4,8,9,101-104,108,109 .. 1N4148
D5,105 ....15V Zener 1W
D6,7,10,11,106,107,110,111 1N4002
D12-15,112-115 ....1N5401
D16 ....red LED
TR1,3,5,9,101,103,105,109 2N3904
TR2,4,6,102,104,106........... 2N3906
TR7,107........ BD244C or TIP42A
TR8,10,108,110 BD243C or TIP41A
TR11,111 ....TIP121
TR12,11 ....TIP126

Miscellaneous

SK1-6,101-106 Quad phono sockets
S1-5,101-105 .. 2-pole pushbuttons
S6 rotary double pole power switch
SK7,107 ......4mm socket terminals
SK8,108 stereo headphone socket
FS1,101 5A PCB mount pigtail fuses
FS2 panel mount fuse holder, 2.5A fuse
T1 toroidal transformer, Hammond 180J70 35-0-35 volt, 90VA (see text for substitution).

the DC at TR3 emitter reaching the output.

11. DC grounding resistor R13 holds the output at zero DC voltage.

Power Amplifier

To the newcomer the power amplifier may look rather complex. It is quite simple, but has a number of features added to make it work exactly as we require it. If we look at the circuit of Fig. 3, we see a circuit that looks like the preamp, but omits the frequency selective network on TR1 collector and the DC blocking capacitor between the two transistors. The gain of the circuit can be calculated:

Gain = (-R5/R6)(-R11/R10)

Now look at Fig. 4. Negative feedback is applied to the input via R_F. If the current fed back via R_F is much greater than the current through TR1, the voltage at the emitter of TR1 can be approximated at $R6/(R6+R_F)$ times the output voltage. If the open loop gain defined by equation (1) is much greater than $(R6+R_F)/R6$ then we have a negative feedback amplifier which has the advantage of less harmonic distortion and a wider frequency response than the circuit without feedback. The theory of negative feedback is an important part of any basic electronics course and can be covered far better by op amp theory, so I do not wish to go into it here. Comparing Fig. 4 with Fig. 5, you

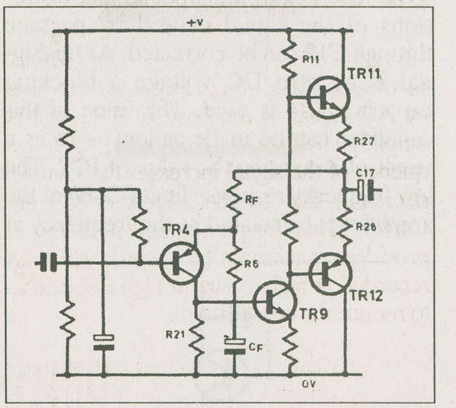


Fig. 6. Adding a complementary output stage (TR11,12).

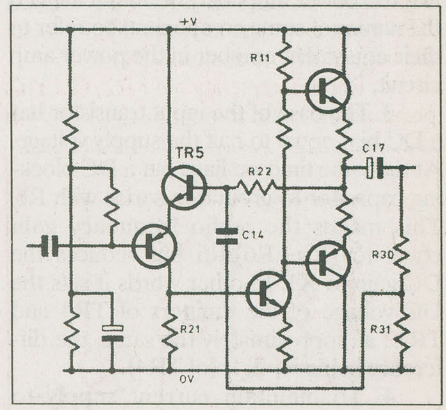


Fig. 7. Improving the distortion factor of Fig. 6.

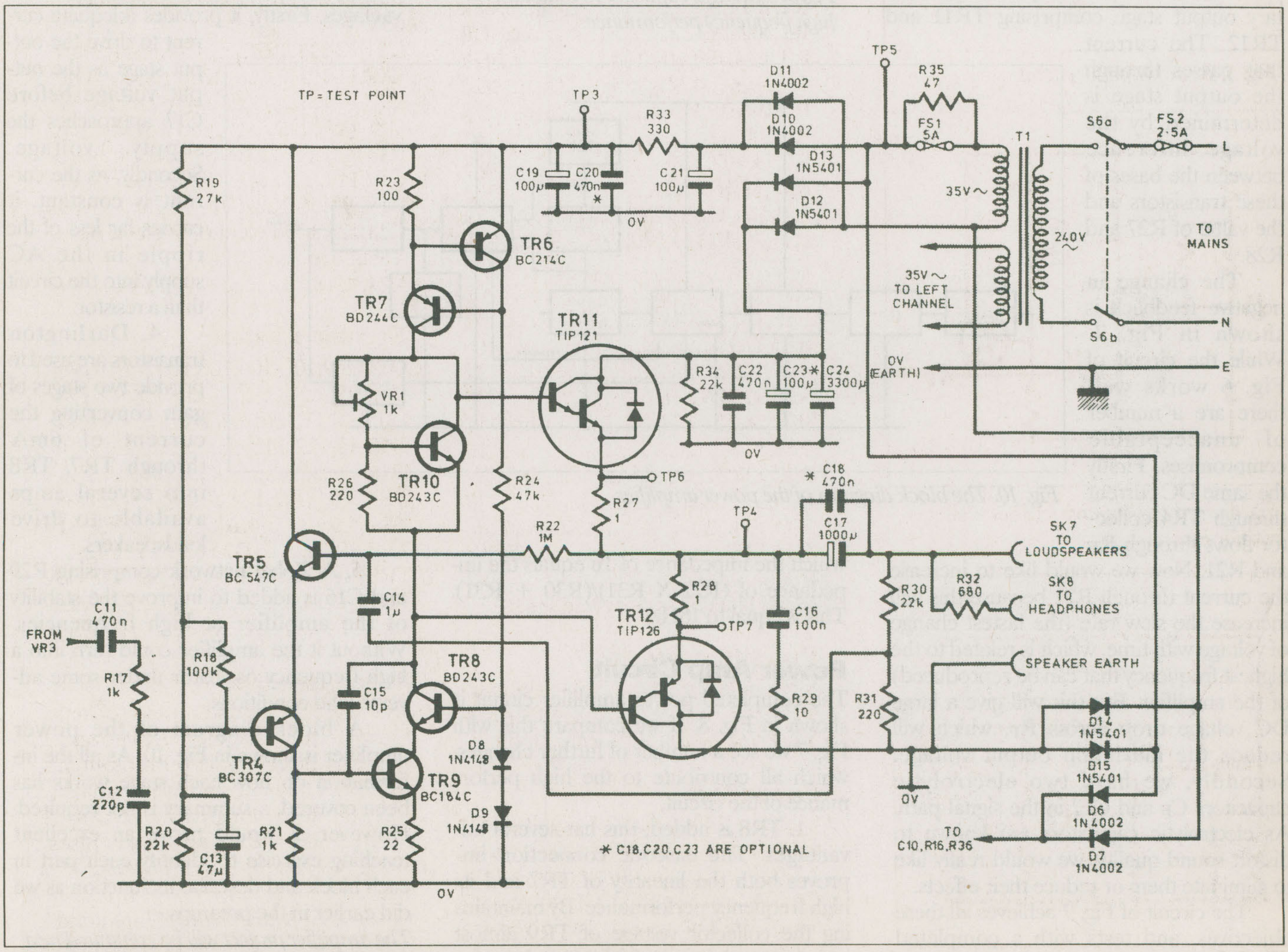


Fig. 8. Complete circuit schematic for the power amplifier section.

will notice that Fig. 5 has a number of changes:

1. The circuit has been inverted by changing the *pnp* and *npn* transistors around.

2. As the circuit is now looking more like the power amplifier, we have changed the names of some components to refer to their equivalent number in the power amp circuit.

3. The base of the input transistor has a DC bias equal to half the supply voltage. At the same time we have put a DC blocking capacitor to ground in series with R6. This makes the audio frequency gain equal to $(R_F+R6)/R6$ but reduces the DC gain to X1. In other words it sets the DC voltage of the emitters of TR4 and TR12 at approximately the same, the difference being $R_F \times I_C$(of TR4).

4. To maintain current supply to TR12, R12 has been reinstated.

In Fig. 6, emitter followers TR12 and R12 have been replaced by a complementary output stage comprising TR11 and TR12. The current that passes through the output stage is determined by the voltage difference between the bases of these transistors and the value of R27 and R28.

The change in negative feedback is shown in Fig. 7. While the circuit of Fig. 6 works well there are a number of unacceptable compromises. Firstly the same DC current through TR4 collector flows through R_F and R21. Now we would like to increase the current through R21 because this will increase the slew rate (the fastest change of voltage with time, which is related to the highest frequency that can be reproduced) of the amplifier. But this will give a large DC voltage drop across R_F, which will reduce the maximum output voltage. Secondly, we have two electrolytic capacitors C_F and C17 in the signal path. As electrolytic capacitors are known to distort sound quality, we would really like to eliminate them or reduce their effects.

The circuit of Fig. 7 achieves all these objectives, and tests with a completed amplifier show that the sound quality is considerably improved. The addition of TR5 enables the current through R21 to be increased. At the same time the current through R22 is greatly reduced by a factor of the HFE (DC gain) of TR5. This enables R22 to be increased. R30 and R31 provide a fraction of the output after C17 to be fed back to the input so that distortions of the signal caused by passage through C17 can be corrected. As this signal is at zero DC voltage a blocking capacitor C14 is used. The value of this capacitor can be made as low as 1u as a result of increasing the value of R22. The low frequency response limit (-3dB) of the amplifier is calculated at the frequency at which the impedance of 1u equals the impedance of (R22 X R31)/(R30 + R31). This is equal to 16Hz.

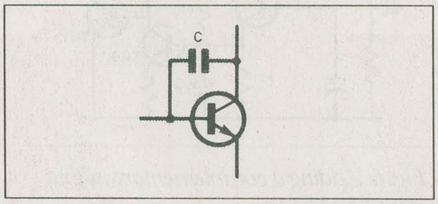


Fig. 9. Adding a capacitor to maintain high frequency performance.

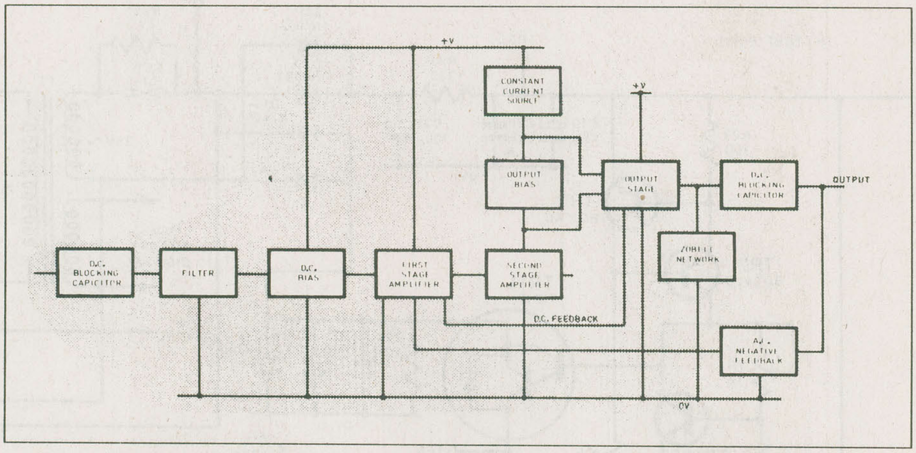


Fig. 10. The block diagram of the power amplifier.

Power Amp Circuit

The completed power amplifier circuit is shown in Fig. 8. If we compare this with Fig. 7 we see a number of further changes, which all contribute to the high performance of the circuit.

1. TR8 is added; this has several advantages. The cascode connection improves both the linearity of TR7 and its high frequency performance. By maintaining the collector voltage of TR9 almost constant, we improve the linearity because the gain of the transistor changes by a small amount due to large changes in collector voltage. Also, transistors have capacitive effects between collector and base, and the effect of varying the collector voltage is to apply feedback (see Fig. 9).

In the actual circuit a real capacitor C15 is used to control the high frequency performance in order to maintain stability. Another advantage is that while a high gain low power transistor is used for TR9, a high power transistor can be used for TR8, and its gain is not so crucial, but the thermal sinking effect of its metal tab reduces temperature generated distortion.

2. A network comprising VR1, R26 and TR10 provides accurate biasing of the output transistors. Mounting TR10 on the heat sink not only improves reliability by reducing the bias voltage when the output transistors get hot, but also improves the sound as a result of lower temperature generated distortion.

3. R11 is replaced by a constant current circuit TR6, TR7, R23; this has two advantages. Firstly, it provides adequate current to drive the output stage as the output voltage before C17 approaches the supply voltage. Secondly, as the current is constant, it carries far less of the ripple in the AC supply into the circuit than a resistor.

4. Darlington transistors are used to provide two stages of gain converting the current of 6mA through TR7, TR8 into several amps available to drive loudspeakers.

5. A Zobel network comprising R29 and C16 is added to improve the stability of the amplifier at high frequencies. Without it the amplifier could turn into a high frequency oscillator under some adverse load conditions.

A block diagram of the power amplifier is shown in Fig. 10. As all the information on how each stage works has been covered, a summary is not required. However, it would prove an excellent teaching exercise to identify each part in each block and describe its function as we did earlier in the preamps.

The amplifier project will be continued next month, with final details of construction, wiring and testing. ■

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Infrared Remote Control

A simple but effective on/off remote control using infrared.

ROBERT PENFOLD

A few years ago remote controls systems were almost invariably of the ultrasonic variety, but thse days the infrared systems are probably more common. They are generally less vulnerable to spurious triggering, and are less likely to annoy your pets. They can also carry quite complex forms of modulation. Their only real drawback when compared to ultrasonic systems is that the range is usually somewhat less, although for many applications a range of only a few metres is required. This is easily achieved using an infrared systems.

Wiring

This infrared remote control system has been kept as simple as possible so that it can easily be built using perfboard, making it fairly easing for complete beginners to electronics construction as well as more advanced constructors.

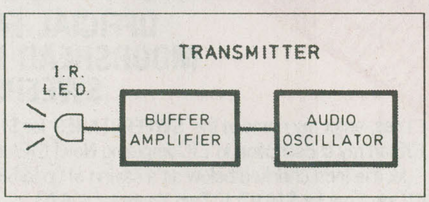
Control System

The range of this control system depends on the emitter device used in the transmitter, and is around two to three metres using a wide-angle device, or about four to five metres using a narrow beam type range. The aim of the transmitter must be quite accurate especially when the system is operated close to its maximum range.

The unit provides a basic on/off action where opening and closing a switch on the transmitter results in the contacts of a relay in the receiver switching on and off. The system is suitable for simple remote control applications such as control of a small model car or boat. The equipment could also be used as a broken- beam type sensor for a burglar alarm system.

The System

In theory it is possible to have a DC system, where the signal from the transmitter is detected by a photocell at the receiver, and the photocell drives an amplifier which in turn drives the relay. In practice such a system is unusable, as it provides a totally in-



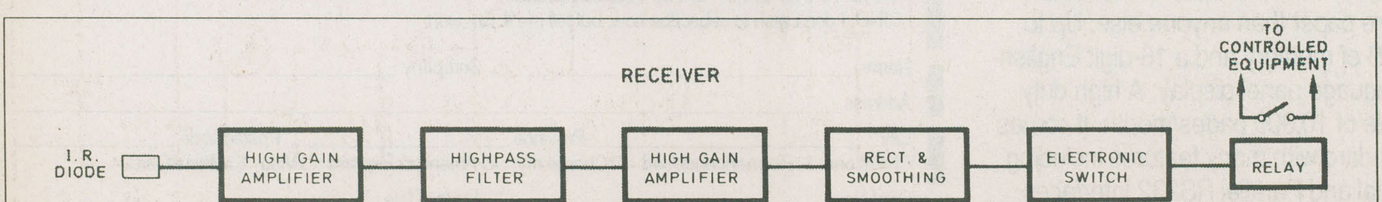


Fig. 1. Block diagrams of the transmitter (above) and receiver.

PARTS LIST

RECEIVER

Resistors

All .25%, 5%

R1 ....22k
R2 ....1M8
R3 ....6k8
R4 ....1k
R5 ....1M
R6 ....4k7

Capacitors

C1,6 .... 100u 10V
C2,3....................................... 22n
C4 ....1u 63V
C5.................................. 2u2 63V

Semiconductors

TR1,3 ....2N3904 NPN
TR2....................... 2N3906 PNP
D1 ....TIL100 IR photodiode
D2,3 1N34 or 1N60 germanium
D4 ....1N914 or 1N4148

Miscellaneous

RLA1 5V or 6V relay with 200 ohm coil or higher, contacts as required
S1 .... SPST min. toggle switch
B1 9V battery or 6 AA cells in holder

TRANSMITTER

Resistors

All .25W, 5%

R1 ....3k9
R 47k
R3 68

Capacitors

C1 .... 100u 10V
C2 .... 4n7

Semiconductors

IC1 .... 555 timer
D1 LD242 high power IR LED (see text)

Miscellaneous

S1 SPST min. toggle or push-button
B1 9V battery

adequate range. Boosting the sensitivity to improve range simply results in frequent spurious operations of the system.

The main problem is that of a certain amount of background infrared signal. This background level could easily be strong enough to swamp the signal from the transmitter.

There is also a problem with the inevitable drift that occurs in high gain DC amplifiers. An inordinate amount of readjustment could be needed with a sensitive DC coupled circuit.

Infrared remote control systems normally use some from of pulse signal, and this one is no exception. The block diagram of Fig. 1 shows the basic arrangement of the system.

Transmitter

The basic transmitter signal is generated by an audio frequency oscillator. The exact operating frequency is not important, and anywhere in the upper regions of the audio range will do. Higher frequencies are less than ideal as the photocell and other parts of the unit will operate at less than optimum efficiency at these frequencies. Lower frequencies could make the equipment a bit sluggish in operation, and would make it relatively difficult to combat the background infrared noise.

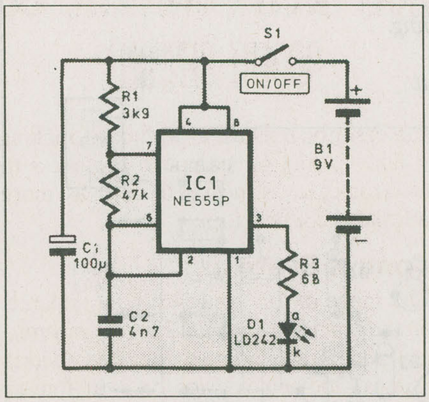


Fig. 2. The IR transmitter schematic.

An LED converts the electrical pulse from the oscillator into pulse of infrared radiation. This component is very much the same as the LED used in clock displays, etc, but its output is just outside the visible-red part of the spectrum and into the infrared zone. It provides no significant visible light output, and does not noticeably glow when activated. In order to give an adequate output level the LED must be driven from the oscillator via a buffer amplifier.

Receiver

The photocell at the receiver is a photodiode. This is a type designed specifically for applications such as remote control systems. It has a spectral response that matches the output wavelength of the LED at the transmitter, and it is a large area device that provides good sensitivity. At least, it provides good sensitivity by photodiode standards.

It still only provides an extremely low level output signal which must be amplified by a considerable amount in order to give sufficient drive to operate a relay. Most of this gain is provided while the signal is still in pulse form, and it is provided by two high gain amplifier stages.

Under most circumstances the background infrared noise level is not a problem. Reasonably constant infrared signals will not affect the unit. It is only those that, like the signal from the transmitter, are amplitude modulated that will interfere with the unit by holding the receiver in the activated state.

The only likely source of such a signal is the 120 Hertz modulated signal

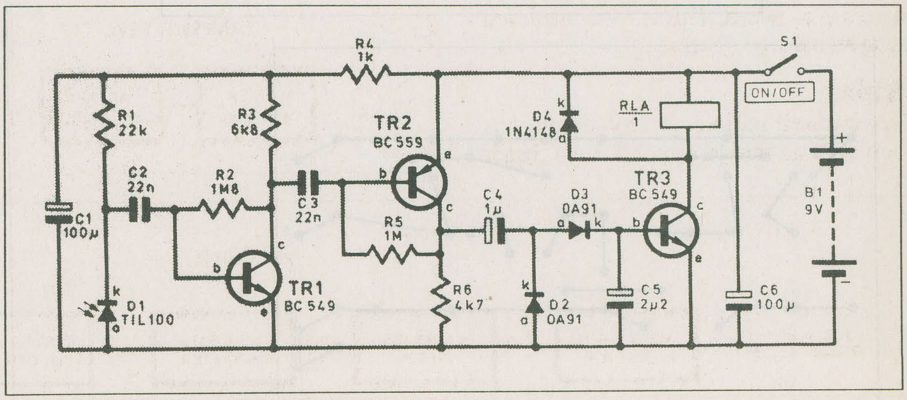


Fig. 3. The IR receiver circuit.

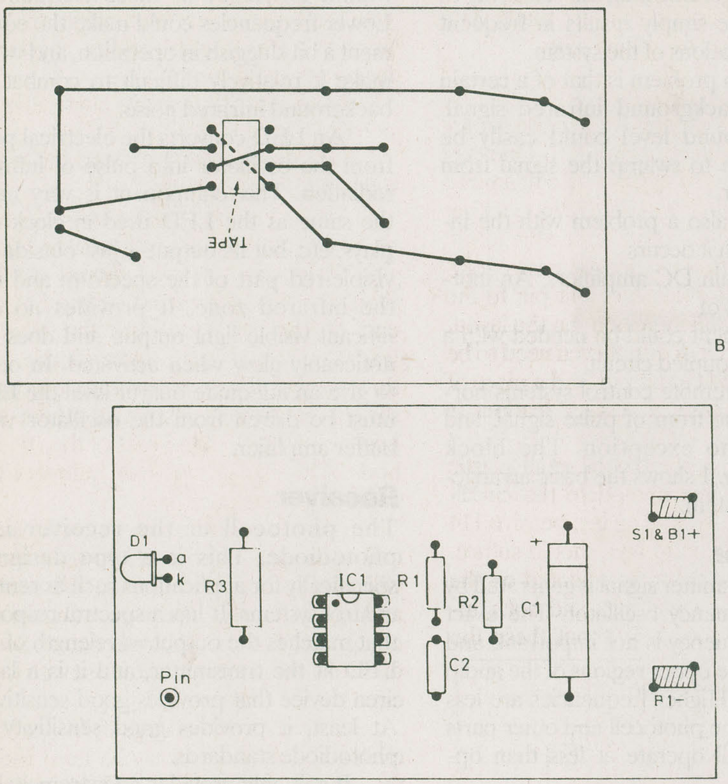
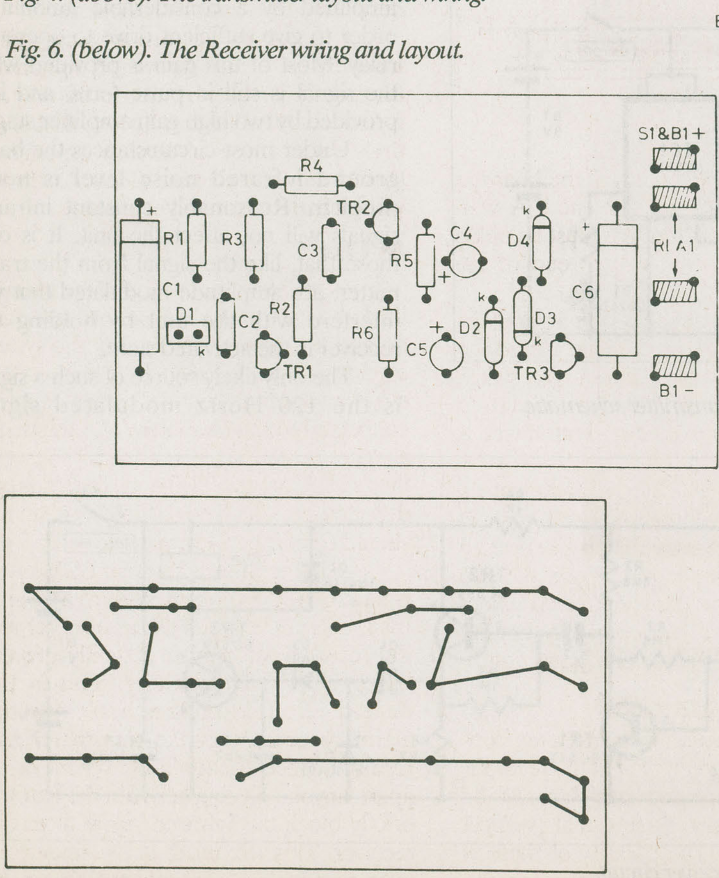


Fig. 4. (above). The transmitter layout and wiring.

Fig. 6. (below). The Receiver wiring and layout.



produced by AC filament bulbs (60 positive and 60 negative pulses per second from the 60Hz mains). As this is at a much lower frequency than the signal from the transmitter, some simple highpass filtering is all that is needed to remove any "hum" picked up by the photodiode from lights.

The output from the second high gain amplifier is fed to a rectifier and smoothing circuit. With a suitable input signal present, the output from the rectifier circuit is a series of positive pulses. These are smoothed to produce a reasonably steady positive DC signal that can drive the relay.

The relay is controlled via an electronic switch that also provides a large amount of DC amplification. This enables the relatively weak output signal from the smoothing circuit to drive virtually any relay having a suitable coil voltage. A relay is merely a switch that is operated by an electromagnet, and its switch contacts are connected in one of the supply leads of the equipment which is to be controlled by the system.

Of course, in the absence of any signal from the transmitter, the output from the second amplifier is only a low level noise signal, and the DC output from the smoothing circuit is inadequate to drive the electronic switch properly. Consequently, the relay (and the controlled equipment) are only switched on when the transmitter is activated.

Transmitter Circuit

The transmitter circuit is shown in Fig. 2, and as will be apparent from this, it uses very few components. It is based on the indispensable 555 timer integrated circuit. In this case it is operated in the standard astable (oscillator) configuration and its output frequency is controlled by timing components R1, 2 and C2. They give an output signal with a markspace ratio of roughly 1:1. In other words, the "on" periods of the LED (D1) are roughly equal to the "off" periods. Resistor R3 controls the output to D1, and it sets this current at a little under 100 milliamps. However, as D1 is switched off for about 50 percent of the time the average LED current is just under 50 milliamps. IC1 has a built-in output stage that enables these relatively high currents to be handled without the need for any external amplification.

Receiver Circuit

The full circuit diagram for the receiver section of the system is shown in Fig. 3. D1 is the photodiode, and it is used here in the reverse bias mode. R1 provides the reverse bias, and normally the current flow

through D1 is only a minute leakage current. However, when it receives each pulse of infrared radiation from the transmitter pulse of increased current flows through the circuit. This generates small voltage pulse at the junction of R1 and D1, and these are coupled to the input of the first amplifier by C2.

Transistors TR1 and TR2 act as the basis of the two high gain amplifiers, and these are both common emitter stages. They are AC coupled and use the same basic configuration, but the first amplifier uses an NPN device whereas the second is based on a PNP type. They each provide a voltage gain of more than 40dB (one hundred times). The highpass filtering is obtained by using fairly low values for coupling capacitors C2 and C3. This gives simple two pole filtering, which is adequate for present purposes.

Diodes D2 and D3 are the rectifier circuit, and C5 is the smoothing capacitor. The output of this circuit drives a common emitter switch (TR3) which has the relay coil as its collector load.

When the relay is de-energized a high reverse voltage can be generated across the coil. D4 effectively short circuits this voltage spike and prevents it from damaging any of the components in the unit. C1, R4, and C6 form a supply decoupling network. These prevent low frequency instability due to feedback through the supply lines.

Construction

Details of the transmitter board and small amount of hard wiring are shown if Fig. 4. Equivalent details for the receiver unit are provided in Fig. 5. Start with the transmitter board which is the more simple of the two. Take care to fit C1 the right way around.

With the axial (horizontal mounting) electrolytics the correct orientation is shown by an indentation around the body of the component (which indicates the + terminal. The shorter lead out of D1 in the transmitter is its cathode (k) terminal.

The LD242 gives optimum range but it is quite directional. Reduced range but a wider beam are obtained using an LD241 or a TIL38. Incidentally, some component suppliers sell these LEDs simply as something like "high powered infrared LEDs" rather than by type number; these should also work well.

An indentation at one end of IC1's body enables its orientation to be set correctly. A socket is a good idea for IC1 in case you have to change it. Connections to it will also be easier if they are made via a holder which has quite long pins.

Wiring Up

The wire which carries the negative supply rail must be routed around IC1. One way of keeping this wire in place is to fit a piece of the double-sided adhesive backing material onto the board. As only a single angle in the wire is needed, an easier solution is to add a printed circuit pin to the board at the point indicated on the layout diagram. In fact it does not even need to be a proper printed circuit pin, and a piece of wire trimmed from a resistor leadout is quite adequate.

There are a number of small plastic boxes that can accommodate the circuit board and battery, and an inexpensive 114 by 76 by 38 millimetre type should suffice. The component board is mounted on the base panel using small nuts and bolts, including short spacers. Without these the

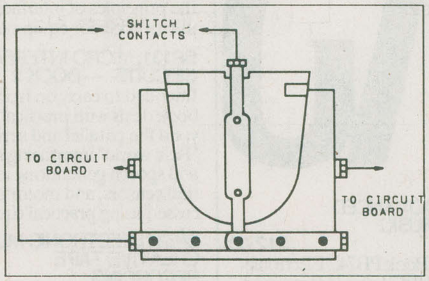


Fig. 6. Typical relay wiring.

component will be forced off the board as the mounting nuts are tightened. A window for D1 to look through must be made at a suitable position in one end of the case.

If the unit is to be used in an application where S1 will need to be closed for much of the time a miniature toggle switch is the best type to use. Otherwise a push to make, release to break push- button type is better.

An alkaline 9V battery is adequate if the transmitter will only be used in short bursts. If it will be used for long periods, a higher capacity battery such as six AA size cells in a plastic holder is preferable. Note that the use of a high capacity battery might necessitate the use of a larger case.

Receiver Construction

A lot of these notes on transmitter construction apply equally well to the receiver, and will not be repeated here. Some of the electrolytic capacitors are radial (vertical mounting) types. The polarity of these is usually marked by + and - signs on the bodies of the components. D1 is mounted with the large surface that carries the type number (and possibly other markings) facing toward R1.

Note that its sensitive surface is the one opposite this,

and that the output from the transmitter must be directed

towards this side of the device. A window must be in the case adjacent to D1.

Make sure the other diodes are also fitted the right way round. A band at one end of the body indicates the cathode leadout, but these days some diodes have three or four bands. In this case, one band should be broader than the others and positioned right at one end of the diode's body. This is the one that indicates the cathode leadout wire.

The relay can be any type that has a coil resistance of about 200 ohms or more, will operate reliably on a six volt supply, and has contacts of adequate rating for the equipment that the unit will control. Some of the 5V relays designed for use with logic circuits such work well.

If the relay is too large to fit onto the circuit board, it can easily be fixed inside the case. It can either be glued in place using a good quality general purpose adhesive, or small bolts will do the trick.

Although the relay may be capable of handling 120V mains powered equipment, the unit should only be used in this way **if it is built an installed in a fashion that is entirely safe.** Those of limited experiences **should only use Remote Control with low voltage battery powered equipment.**

In Use

As with any projects, give the wiring a final and thorough check before switching on and testing the system. Try the system at close range initially. It can be tested even without having the relay contacts connected to the main item of equipment, as most relays produce a "click" sound as they switch on or off. The maximum range depends on the type of LED used, but should be at least a few metres.

A simple infrared system of this type is strictly a line of sight system, and anything opaque between the transmitter and the receiver will almost certainly prevent the system from working. This is the desired effect in broken beam intruder alarm systems. With the transmitter and receiver space a couple of meters or so apart, anyone passing between the two will briefly block the infrared signal from the receiver. This will result in the relay contacts opening momentarily, which can be used to activate a burglar alarm system. ■

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BRICKS is a classic implementation of "Little Brick Out", a game which dates back to the earliest personal computer. Kill bricks and relive a bit of history.

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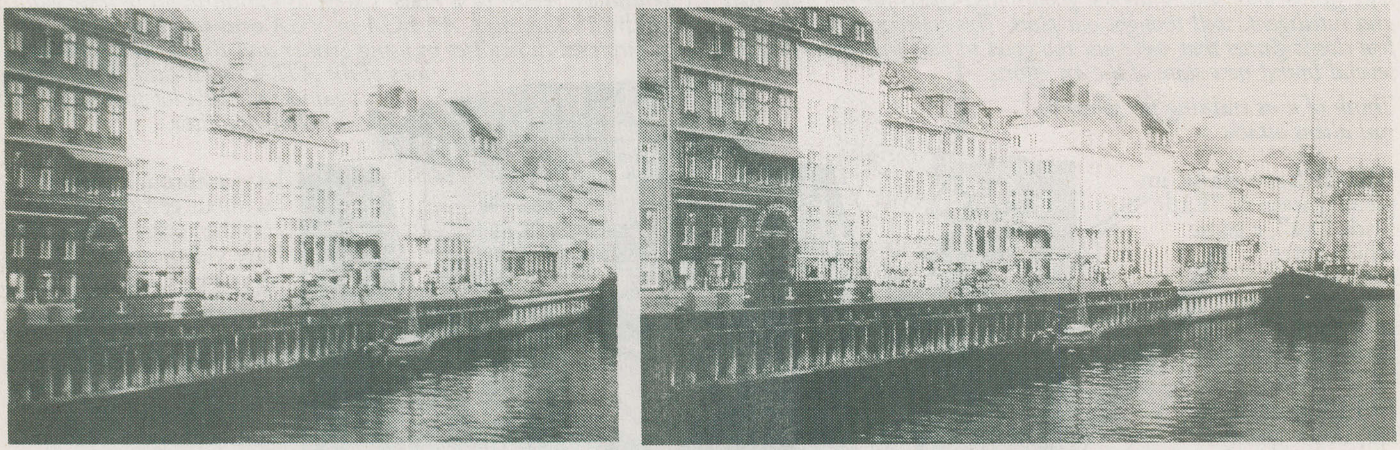


Today's standard NTSC image, with an aspect ratio of 4:3 (left) and the proposed HDTV 1050-line, 5:3 image (right).

In the early 1950s, the National Television Standards committee set the North American standards for color broadcasting that would be compatible with black-and-white (also NTSC). It's been with us ever since, despite the fact that it's a less than perfect system, no match, for instance, for the European PAL TV system (proponents of other systems have said that NTSC stands for Never The Same Color).

Despite the advances made in improving NTSC with microprocessor control and so forth, it's time for an upgrade. Technically, there really isn't a problem: it's fairly straightforward to design widescreen broadcasting that can improve the present 525- line scan to 1,000 lines or more. The real tangle starts when compatibility has to be taken into account. The radio frequency spectrum is pretty well jammed these days, and it just isn't possible to have two systems going at once. Switching to an incompatible HDTV system that would cut off all present sets is unacceptable (might be nice to be without TV for a while, though...).

A number of systems exist, and as you'd expect, the designers would dearly love to see theirs as the standard.

The UK

In Britain, where they make much more use of Direct Broadcast Satellite than we do, it's been proposed that HDTV should be implemented without regard to compatibility, using a DBS satellite that's due to go up in 1992. The TV owner would require a dish to receive the 12GHz signal, plus a special set, plus (possibly) a descrambler. The lure of profits may mean that their HDTV will be pay-TV.

Two systems are available. One has been proposed by Sony, using 60 fields per second instead of the present 50, and a scanning rate of 1250 lines, though in the early stages it would broadcast at the present 625. The Sony system is not compatible with existing sets, even with an adapter. The other method is the Eureka, using a compatible 1250 line scan at the 50-field rate. Existing sets would see only the center portion of the widescreen frame, much like watching a widescreen movie on today's TVs. The Eureka broadcasts a 625/50 signal, but embedded in it is a digital code that lets an HDTV set expand the picture to 1250 lines.

As far as cost to the consumer, it's anybody's guess. It's of interest to note that a survey in the UK asked people if they would be willing to spend the equivalent of about $700 to buy the satellite dish required for DBS HDTV, and only 7% said yes. The number would probably be far lower if the cost of a new widescreen TV set had been added to the price.

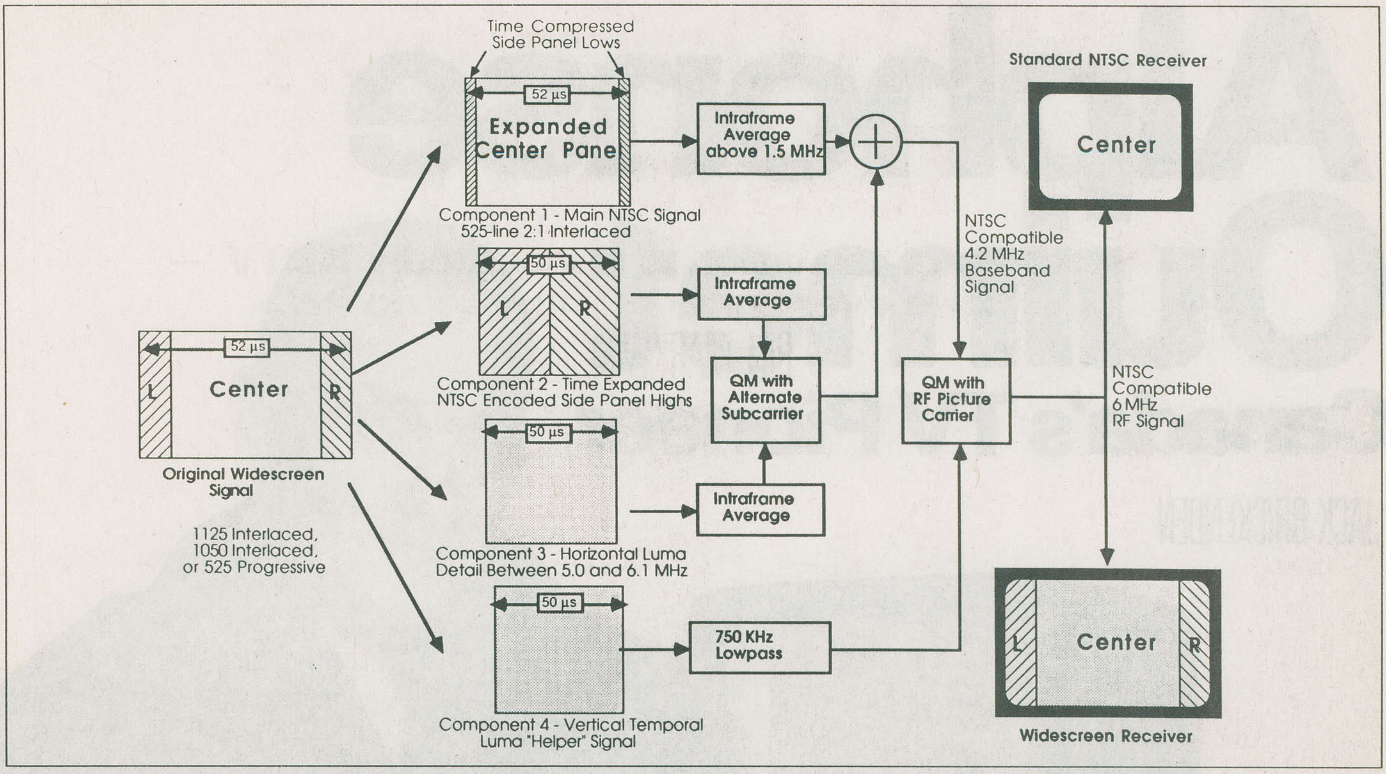
Japan

In Japan, home of many massive electronics companies, it's not surprising that several HDTV systems have surfaced. One is the Sony mentioned above, and another is MUSE (Multiple Sub-Nyquist Sampling Encoding) from NHK, the Japanese Broadcasting System. Neither system is compatible with the European PAL or the North American NTSC standards. A consortium of companies has developed another system called Hi Vision, an 1125/60 standard which is being pushed in Europe and the US.

The US

Whatever system is chosen as the new US standard will become the Canadian one as well. The Hi Vision standard has been supported by CBS, though the Federal Communications Commission is going to look at all possible options before making a decision.

Another system being touted by NBC



A block diagram of the proposed ACTV-II system from Sarnoff Research. This system, which requires some changes to the frequency spectrum, would allow a second channel for digital audio, etc.

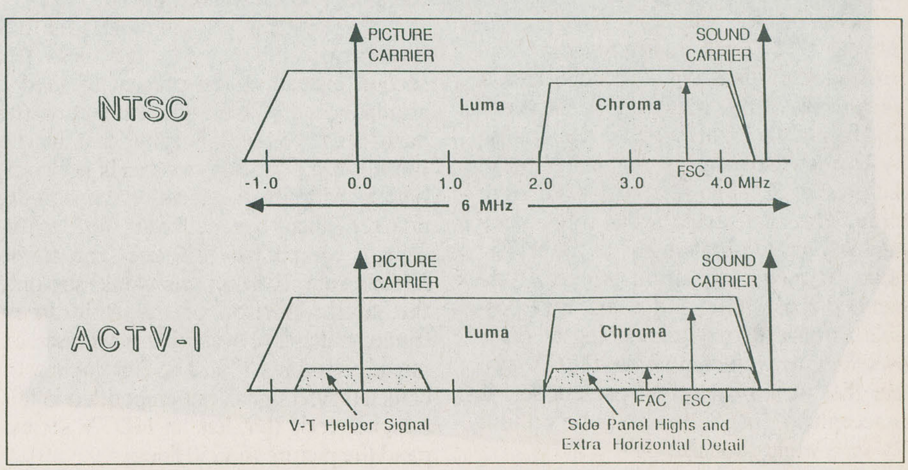
is the Advanced Compatible Television (ACTV) from the David Sarnoff Research Centre, formally RCA Labs. It doubles the scan rate to 1050 lines, and stays with the existing 29.97 frames/second (with two image scans per frame to reduce flicker, the same as today's sets). It's widescreen, with an aspect ratio of 5:3, as opposed to today's 4:3 screen. The luminance resolution is 410 lines horizontal, and the chrominance resolution is the same as NTSC (about 300 horizontal lines). The enhanced widescreen picture is delivered within the existing 6MHz channel width.

This is the first stage, one that gives good HDTV while remaining compatible with existing TVs and VCRs. The second stage is to add a second channel; this could be used for text information that would be available onscreen at the touch of the remote control, and full digital sound could be implemented. In addition, the horizontal resolution is increased to 650, giving an even higher resolution to the image. However, the second stage requires some reallocations in the frequency spectrum, a move that might be delayed for some years. The first step would be ready in the early 1990s; the hardware has already been demonstrated in Ottawa in October, 1987. Three new members have joined the ACTV development team: American Television and Communication Corporation, Home Box Office, and ABC. This should give it lots of political leverage.

Other Ideas

To fill the gap between NTSC and the implementation of HDTV, we'll probably be seeing a number of enhanced receivers (EDTV), using digital and analog processing to improve the resolution. A megabyte of RAM in the set would allow the processor to fill in between the dots for a finer image, plus windowing, zooming, etc. Hitachi has developed a third-generation version of NTSC; this would improve sharpness and resolution without affecting compatibility. Whether this system makes any headway depends on how far we are from full HDTV.

The flexibility of the microprocessor has resulted in proposals for TV sets that could adapt to any conceivable standard. However, this would raise the price of every set and result in consumer confusion and hesitance (remember Quadraphonic Sound?). ■



A comparison of the present 6MHz NTSC signal and the Sarnoff ACTV signal for the first stage of implementing a compatible HDTV.

Alphonse Ouimet

Canada's TV Pioneer

JACK BRICKENDEN

J. Alphonse Ouimet, the man who probably contributed more than any other Canadian in bringing television to this country, died at the age of 80. He had been actively involved in the development of TV since the early 1930s.

To the general public Al Ouimet was best known for his years as president of the Canadian Broadcasting Corporation from 1958 to 1967. He was a professional engineer, so his route to the number one post at CBC was through the technical end of broadcasting. First, he was a research engineer in 1934 for the Canadian Radio Broadcasting Commission, which predated CBC, and then CBC operations engineer, then chief engineer, assistant general manager, general manager, and ultimately president.

He was also the first Franco-Canadian to achieve the position of president of a national organization.

Within the trade he had made his name as an engineer and visionary long before that.

Radio Vision

After graduating from McGill with his degree in engineering, Al Ouimet joined a struggling young company called Canadian Television Limited in 1932. This was a small, under-financed organization that was working on what was commonly referred to in those days as "radio vision". Today we call it television. He was Research Engineer.

"Radio vision" in the thirties was primitive, but it worked. The prototype TV receiving equipment that the fledgling company produced for commercial distribution in Canada was designed for CTV (no relation to the present CTV) by young Al Ouimet, who was still in his early twenties.

"We produced in those early days a very coarse picture which showed just enough detail to barely recognize one's own mother on a full face close-up," Ouimet explained. The receiver operated on the mechanical system of scanning and the picture was in black and red. A revolving lens disc traced 60 lines on the screen, compared with the 525 lines of the modern TV receiver. It was a bit like looking at a picture through a half-closed venetian blind. The company hoped to use this prototype to develop and sell commercially.

At that time the different experimental systems around the world used a variety of dummies to test their signals. NBC, in the United States, had Felix the Cat. The British had a papier mache head of some kind. Canadian Television Limited couldn't afford a dummy, so individual staff members used to take turns as "test pattern" while the others worked.

Al Ouimet was always in great demand because he had something the others didn't have. A close-up of Ouimet's face revealed a gap between his upper incisors that was the perfect focal point for the TV tests.

"Not only am I one of Canada's first television pioneers," he used to say, "but I was certainly its first test pattern."

But the CTV of 1932 was too far ahead of its time. The shoe- string company was technically successful but lacked the money to finance the development and broadcasting of their TV signals in those early untried days, and they went broke. They were also up against the technically-competitive electronic system of TV scanning which had begun to outstrip the mechanical system. The limitations of the mechanical system had become apparent in Britain, which had run the two systems parallel for some time and had concluded that the electronic process was the one with the future.

Al Ouimet's early TV set still exists and has been on display at the Museum of Science and Technology in Ottawa. Today's electronic scanning system, of course, has far outpaced the early mechanical method, but it is still possible to produce a scanning signal on the old 1932 model.

Ouimet was often concerned that he would be given credit he didn't deserve in connection with the 1932 TV receiver. In a note he wrote to CBC's publicity head on April 22, 1964, he said:

"I note that I am credited for having constructed that receiver entirely. This is an oversimplification. While I did design this receiver from an electronic, electrical and optical standpoint, I did not construct it mechanically. This was done by an associate named Goodridge, and he would probably be hurt if he happened to come across our CBC publicity in this respect. I believe it would be more accurate if the caption in the booklet (re the CBC Broadcasting Museum) as well as the explanatory cards accompanying the receiver would simply state 'the set shown here was designed by J.A. Ouimet...'."

The CRBC

In 1934 Ouimet joined the CRBC, the forerunner of CBC, as a research engineer. At the time he was hired one of his stated areas of responsibility was to explore the development of television for the people of Canada. He was the perfect choice for this assignment and kept in close touch with the television development of many other countries. He was soon recognized as CBC's undisputed expert on the new medium.

When CRBC was replaced by the Canadian Broadcasting Corporation in 1936 he was made operations engineer and charged with the responsibility of organizing the management of CBC's rapidly expanding radio production, transmission and facilities. He became CBC's chief engineer in 1948. He was also appointed coordinator of television at the same time, and gradually assumed full responsibility for the establishment of the national television service launched in Canada in 1952.

He became general manager in 1953, the youngest in CBC history.

The actual task of organizing and building two parallel national TV services, in English and French, was formidable. Because of its much greater complexity and size, the TV service could not be brought in as a simple integrated extension of the existing radio service. It had to be conceived and developed as a separate entity.

To do the job CBC had to quadruple its staff from 1,500 to 6,000. Expenditures also climbed from $12 million to nearly $50 million in the first five years of television. The entire organizational structure had to be recast and decentralized. Totally new departments were created and existing services greatly expanded.

Thousands of new personnel were hired and, as none were available in Canada with previous TV experience, all had to be trained in the complexities of the new medium. Also, thousands of Canadian artists and performers were developed for the new medium and its entirely new program techniques and concepts. Commercial policies were reviewed and radically changed as sales efforts had to be greatly intensified to help bear the increasing costs. Commercial revenues were increased tenfold in the first six years. With the new technology large production centres, transmitters and buildings had to be constructed.

J. Alphonse Ouimet had led the most complex, sensitive and controversial public enterprise in Canada through its most difficult years. These were years which Peter Newman described as "the distemper of our times" and which were marked by ferment in Quebec and instability in Ottawa, by the worldwide crises of authority and confrontation, and by the sudden emergence of the permissive society. In meeting this challenge he brought to the discharge

of his duties a rare combination of talent, education and experience. His perfect knowledge of both French and English, his academic preparation and his continued interest in humanities and science, his broad vision, leadership and total dedication coupled with his passionate love for his country served Canada well at a particularly difficult time in its political, social and cultural life.

Reg Horton worked in CBC Engineering under Ouimet during the early radio days and was the first TV technical director for the English network when television came to Canada in 1952. He recalls the never-ending struggle to get enough money to do his job properly. "We needed technical books," said Horton. "We were forever being told that the budget didn't allow for this item or that item. I remember talking to Al about this problem and he said: 'Well, if one person gets one idea from one book it's worth it.' We had no trouble getting technical books after that. Al believed that we could always afford quality."

"His work was always marked by a firm belief in the independence of public broadcasting"

T.R. Ide, former chairman of TV Ontario described Ouimet as "a passionate defender of public broadcasting, of a second CBC channel... a towering figure in a period of technological and social change."

Al Ouimet served CBC and the Canadian public for 33 years, nearly half of it as chief executive (general manager and then president). He had planned and built one of the most important television broadcasting systems in the world, both in terms of its programming and its physical and geographical dimensions. He had brought together a highly complex public service organization of about 9,000 employees of two cultures and many diverse disciplines, with a yearly budget of two hundred million dollars. Over the years he had managed well over a billion dollars without a single budgetary deficit.

In paying tribute to Alphone Ouimet at the time of his death, the present CBC president, Pierre Juneau, said:

"His work was always marked by a deep attachment to the Corporation, and by a firm belief in the principle of independence for public broadcasting... a principle which he continued to defend even after he left public life."

In addition to his nine degrees and honorary doctorates, Al Ouimet was presented with nine decorations and awards as recognition of his lifetime of service:

Ross Medal of the Engineering Institute of Canada;

Archambeault Medal of L'Association Canadienne Francaise Pour L'Advancement des Sciences;

Julian C. Smith Medal of the E.I.C.;

Fellowship of the Institute of Electrical and Electronic Engineers;

Sir John Kennedy Medal... the senior award of the E.I.C.;

Made Companion of the Order of Canada, Canada's highest decoration;

McNaughton Medal... senior Canadian award of the I.E.E.F.;

Special Award... Society of Motion Picture and Television Engineers;

Canadian Council of Professional Engineers Gold Medal.

Al Ouimet was a Life Member of the Corporation of Professional Engineers of Quebec, Senior Member of the Engineering Institute of Canada, a Fellow and Life Member of the Institute of Electrical and Electronic Engineers, Member Titulaire de Comite International de Television, and Member International Broadcast Institute.

After he left CBC in 1967 Mr. Ouimet oversaw a United Nations Educational, Scientific and Cultural Organization conference on broadcast satellite technology. He was president of Telesat Canada from 1969 to 1980.

Pierre Juneau: "He could justly be called the father of Canadian television." Al Ouimet might have been too modest to accept such an accolade, but those who knew him and worked with him have no such reservation. ■

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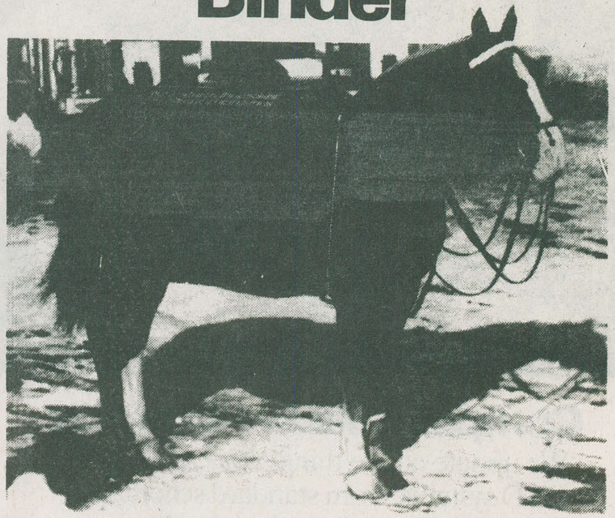


One day one of Tornto's Finest parked his horse at the firehall next door to us, making him fair game for yet another in our series of great, unforgettable, stupid binder ads.

Our binders are covered in sturdy vinyl, and use spring rods to hold a year's worth of magazines without cutting or punching, allowing them to open flat for reading or photocopying.

They're available from us for $9.75, which includes postage and handling. Ontario residents add 8% (Ouch!) provincial sales tax.

We would also like to point out that
(a) Toronto policemen generally use cars, and
(b) because the binders are magazine-sized, they work as blankets only if the horse is under 36 inches long.

Send to:

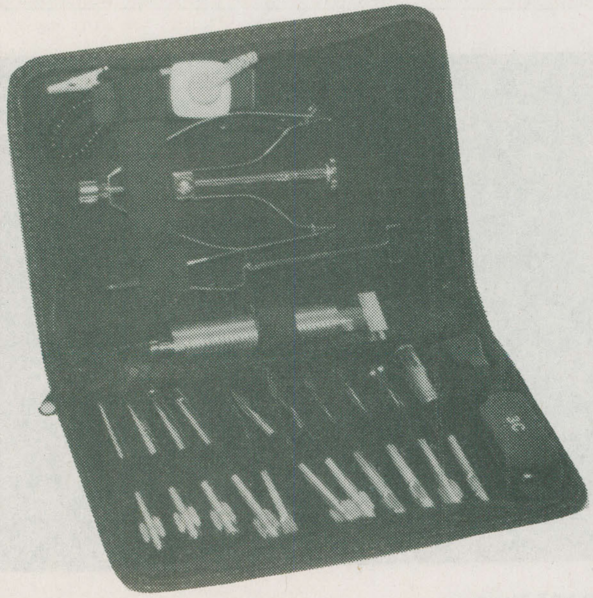
Binders
Moorshead Publications
1300 Don Mills Road, Toronto, Ontario M3B 3M8

NEW PRODUCTS

Earth Tester

If you need to take soil resistivity and ground electrode resistance, Megger Instruments presents its Megger DET 5, a digital tester with rechargeable cells. Weighing 1.4kg, the DET 5 offersranges of 0.01 to 19.99 ohms, 0.1 to 199.9 ohms, and 1 to 19,990 ohms. The DET 3 model offers hand-cranking for remote applications where battery use is not practical. From Metermaster division of R.H. Nichols Co. Ltd., 08 Vinyl Court, Woodbridge, Ontario L4L 4A3, (416) 851-8871, Fax 851-6862. There are also branches in Ottawa and Montreal.

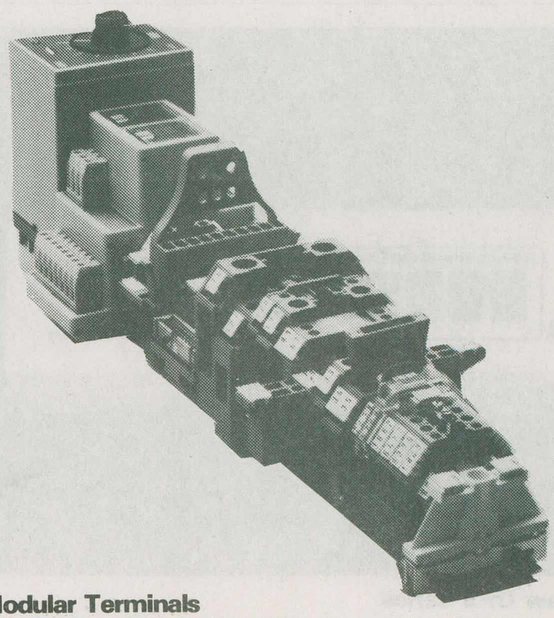
Circle No. 7 on Reader Service Card



Computer Service Tool Kit

KB Electronicss announces the addition of the CSK-32 Computer Service Tool Kit to its line of test equipment. It contains an antistatic wrist strap, IC inserter/extractor, square IC extractor and a series of multiple extension screwdrivers covering all common screw types. All tools are housed in a zippered carrying case. KB Electronics, 355 Iroquois Shore Road, Oakville, Ontario L6H 1M3, (416) 842-6888.

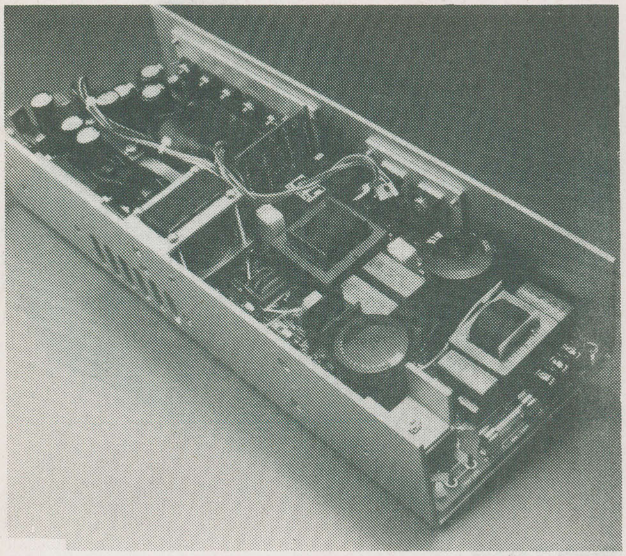
Circle No. 8 on Reader Service Card



Modular Terminals

Electrovert now offers a service supplying pre-assembled, rail-mounted terminal blocks to the customer's own specification. There are over 250 types which can be combined with DIN mountable relays, switches, filters and other electromechanical devices. Contact Electrovert Ltd., 46 Dufflaw Road, Toronto, Ontario M6A 2W1, (416) 787-0243, Fax: 787-6812.

Circle No. 9 on Reader Service Card



Switching PSU

The Hammond Power Supply Group has introduced a new 5-output 400W switcher using a modified version of magnetic amplifier design with a magnetic control circuit said to be more reliable than active devices. Standard features include overvoltage protection, thermal shutdown, independent current limits on all outputs, etc. Output voltages can be modified to requirements. Hammond Manufacturing, 394 Edinburgh Road N., Guelph, Ontario N1H 1E5, (519) 822-2960, Fax 822-0715. The Toronto line is (416) 456-3770.

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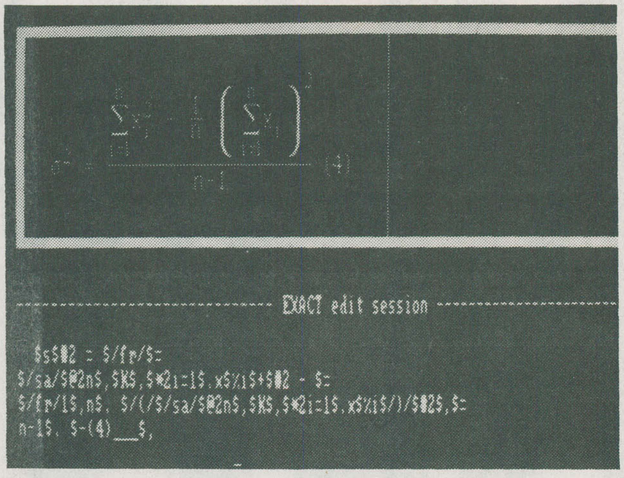

Math Typesetting Program

If you use most popular word processors on a PC and need to insert complex mathematical symbols into your text, Technical support Software offers Exact, a RAM resident program that includes 20 fonts with over 1,000 symbols. It prints out on all common dot matrix printers and will display on any graphics card, including the Hercules. It can also remap the keyboard for printing in Arabic, Russian or Hebrew. The latest version of Exact has revisions for WordPerfect, including version 5.0, WordStar, Word, etc. Contact them at 72 Kent St., Brookline, MA 02146, (617) 734-4130, Fax 734-4160.

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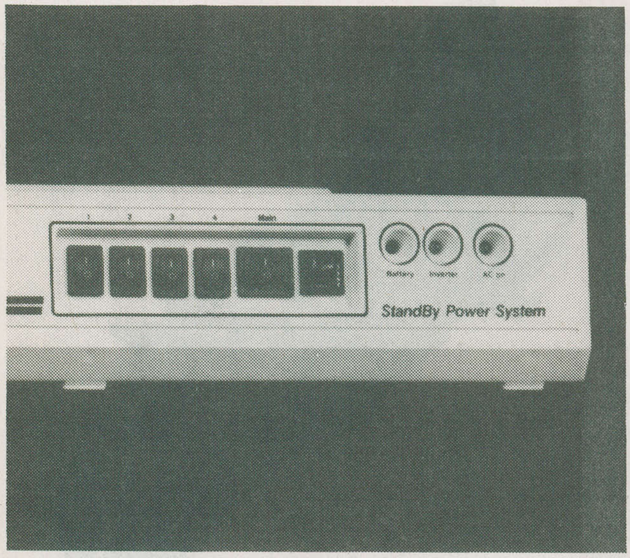
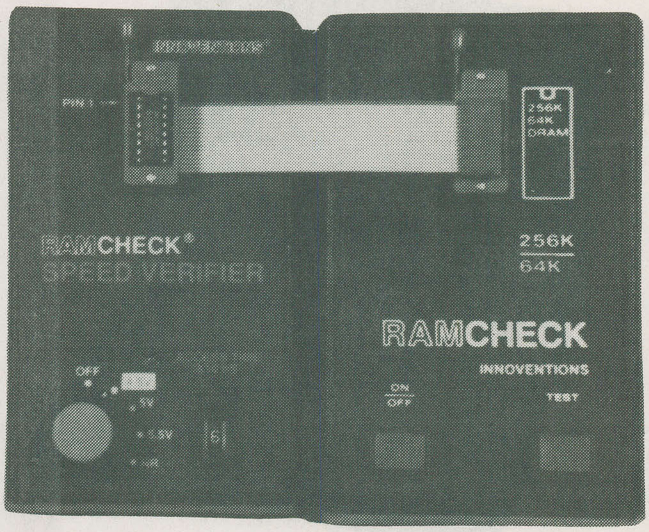


New UPS Series

Power Control Inc., whose excellent uninterruptible power supplies have been reviewed in these pages, offers a new line of slimline supplies, the ESL-350 and ESL-700. They provide emergency AC power for up to 16 minutes at 350 watts and 700 watts respectively. Solid state switching allows transfer to the internal circuit in less than one millisecond. Internal filters remove spikes, noise and surges. Contact them at 175 Toryork Drive, Toronto, Ontario M9L 2Y7, (416) 747-6644, Fax 747-9070.

Circle No. 12 on Reader Service Card



RAM Testers

If you have RAM chips that need verifying for condition or speed, Innoventions Inc. offers the RAMCheck, an 8088-based device that tests every cell in 64K or 256K RAM chips. Another unit, the RAMCheck Speed Verifier, tests the same chips for speed over the range of 30ns to 150ns and can work stand-alone or in conjunction with the RAM tester. Contact them at 10804 Fallstone Rd., Suite 214, Houston, Texas 77099, (713) 879-6226.

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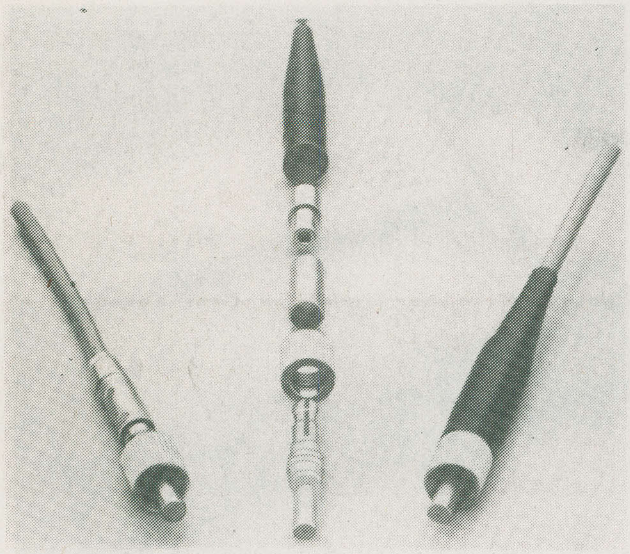

Fibre Optics Connectors

An SMA-type commercial crimp-and-cleave connector that can be terminated in less than 3 minutes is available from Ensign- Bickford of Connecticut. A metal sleeve is crimped directly onto the fibre's hard cladding and then the fibre is cleaved with a circumferential scribe tool, eliminating the polishing steps required by epoxy-type connectors. Ensign-Bickford Optics Co., 16 Ensign Drive, Avon, CT 06001, (203) 678-0371, Fax 674-8818.

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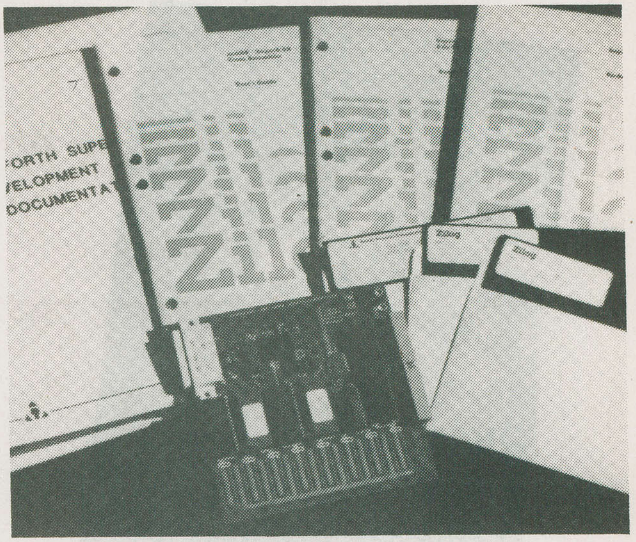

Forth Development Lab

Forth, a computer language that was in vogue among hackers a few years ago, is alive and well. Inner Access introduces the Super8 Development Lab, which consists of a Zilog 20MHz Super8 single-chip microcomputer on a card that fits any IBM compatible computer, a Forth ROM set, monitor ROM, and IBM PC or compatible software. It allows you to develop sophisticated new products using the Zilog Super8 and Forth, all for $295 US. Contact Inner Access, Box 888, Belmont CA 94002, (415) 591-8295.

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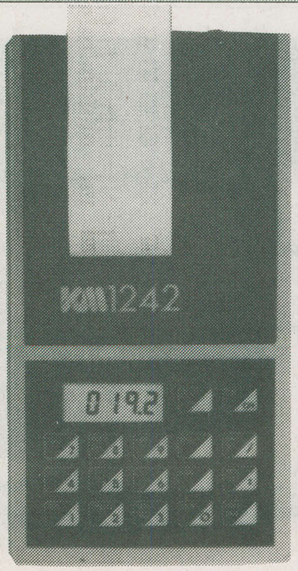

Printing Thermometer

The Kane-May KM1242 thermometer has an LCD display, K-type sensors, five channels and a selectable sampling rate from 15 seconds to 20 minutes. It can also calculate the average, minimum and maximum readings of each channel at the end of each run. Results are printed out with the time for each reading. Kane-May of the UK is represented in Canada by Instrument service Laboratories Ltd., 3351 Jacombs Road, Richmond, BC V7V 1Z6, (604) 278-4511.

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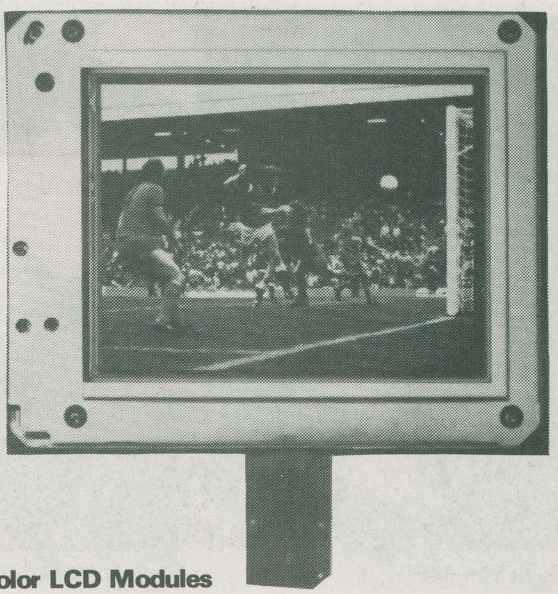

Color LCD Modules

Although they're available only to original equipment manufacturers (so far), the Sharp color LCD module comes in three or four inch sizes and is said to rival CRT performance. They offer 92,160 pixel performance for the 3-inch and 115,200 for the 4-inch. Maybe we really will see that TV set that hangs on the wall like a picture. OEMs can contact Sharp's Microelectronics Division at (201) 529-8757.

Switch Brochure

Oak Switch Systems of Crystal Lake, Illinois, is offering their brochure custom switch assembly services. Included are capabilities for product design and development, manufacturing, assembly, testing, etc. They're represented in Canada by R.D. Associates, 1262 Don Mills Rd., Suite 206, Don Mills, Ontario M3* 2W7, (416) 444-0959, Fax 441-9667.

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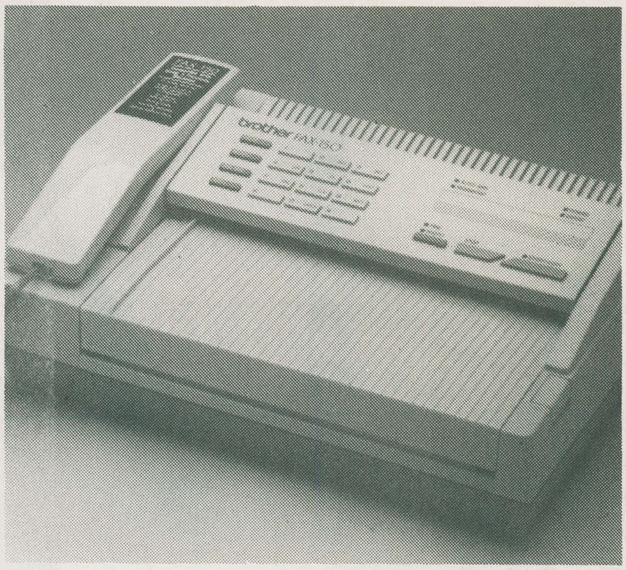
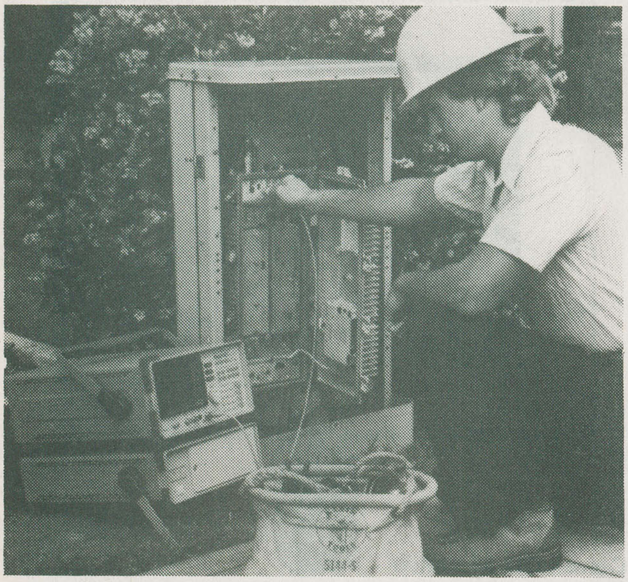


Brother Fax

Brother International Corporation announces the Fax-150 facsimile unit. It features 16 levels of gray scale for accurate transmission of halftones and graphics, a built-in handset, speed dialing, built-in speaker, a numeric keypad and an optional password system allowing the user to "avoid junk Fax" (we want one!). Available through a Canada-wide network of Brother dealers. If you can't locate a dealer, contact the head office at (514) 685-0600, Fax 685-0700.



Portable AC Source

HP announces the HP 85901A portable AC power supply, a lightweight unit that can power test equipment with 200W continuous, 230W maximum, 115V or 230V output. The charge typically exceeds one hour at 100W output. The internal recharger works in less than six hours. The 85901A is $1,413 Canadian. Hewlett-Packard Canada Ltd., (416) 678-9430.

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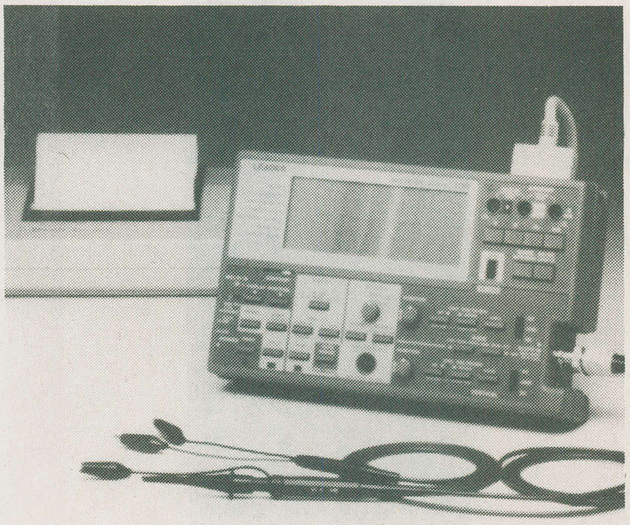

DMM/Storage Scope

Leader Electronics has introduced a new combination 2-channel Digital Storage Oscilloscope, the Model 200, featuring autoranging, an LCD readout, storage of three waveforms per channel, and a digital multimeter section. The DMM has the usual AC, DC and resistance functions, plus a low-ohms mode. Contact Omnitronix Ltd., 2410 Dunwin Drive, Unit 4, Mississauga, Ontario L5L 1J9, (416) 828-6221, Fax 828-6408. Also in St-Laurent, Quebec, (514) 337-9500.

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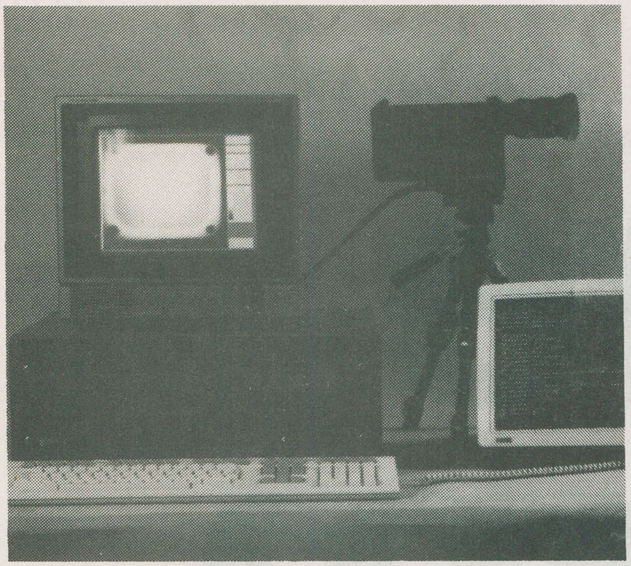
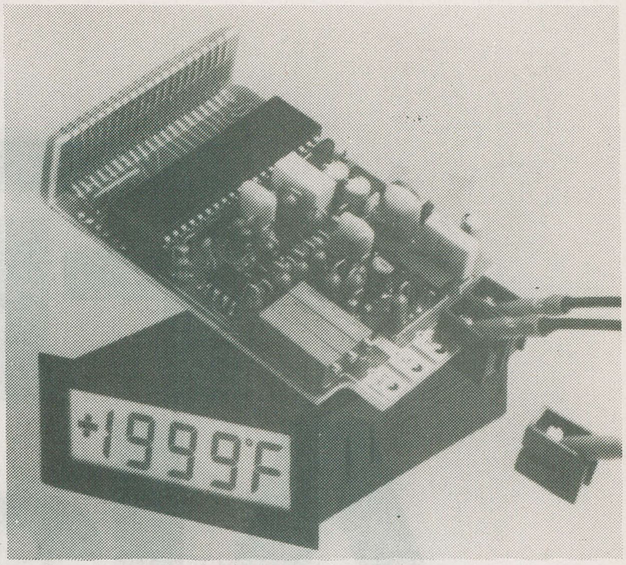


Infrared Recording Unit

The Agema Burst Recording Unit records and stores the fast dynamic infrared images generated by a Thermovision 800 scanner. Sequences are captured on a computer, allowing storage and retrieval at any sampling rate. Slow motion, fast forward and reverse search are included. Since all data is stored in digital form, it is available for further processing. Agema Infrared Systems, 5230 South Service Road, Suite 125, Burlington, Ontario L7L 5K2, (416) 637-5696.

Circle No. 22 on Reader Service Card



Temperature Meter

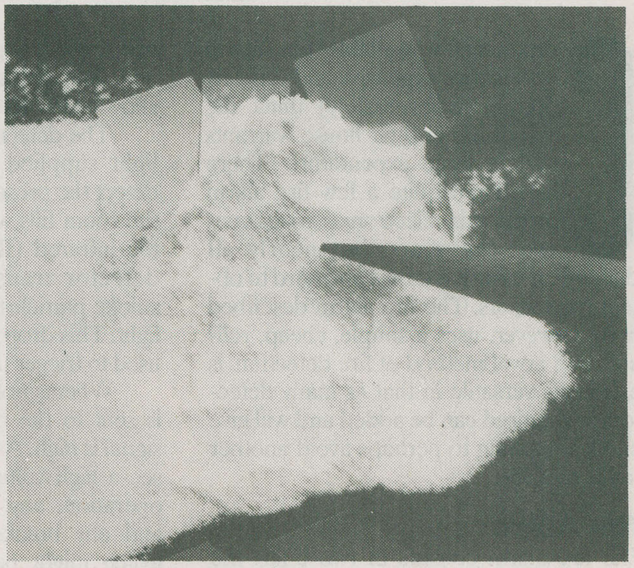
Texmate has recently released their TM-35 and TM-35X range of thermocouple meters, suitable for use with either J or K type thermocouples and available in LCD or LED format. They feature thermocouple break detection and indication, Display Hold and Test, and a differential input. Contact Metermaster division of R.H. Nichols Co. Ltd., 80 Vinyl Court, Woodbridge, Ontario L4L 4A3, (416) 851-8871, Fax 851-6862. Also with offices in Ottawa and Montreal.

Circle No. 23 on Reader Service Card

Leslie Speaker Emulator

The Brianizer is a Leslie Model 147 speaker emulator, with a phase compensated active crossover followed by speed dependent tremolo, flange, and Doppler shift circuitry in both the horn and bass rotor channels. FET switching allows the effect to be noiselessly enabled and disabled. The motor accelerations and decelerations have been accurately modelled. Avalanche Effects Inc., PO Box 582, Stn. C, Toronto, Ontario M6J 3R9, (416) 537-2088.

Circle No. 24 on Reader Service Card



Superconductor Powders

Substrates, precursor powders, and yttria stablized diffusion barrier powders for making superconducting ceramics are available from Meller Optics of Rhode Island. Substrates include strontium titanate, magnesium oxide and cubic zirconia; materials are available from stock. Meller Optics, Inc., 120 Corliss St., PO Box 6001, Providence, RI 02904, (401) 331-3717.

Circle No. 25 on Reader Service Card

Fire Alarm

An expensive system that will detect a fire in any room, garage etc.

GARY CALLAND

Commercially available fire alarm systems are expensive and very few people (unfortunately) think the risk of fire in their house warrants such a large expenditure. There have been quite a few fire alarm projects in electronics magazines over the years, but nearly all depend on using expensive and hard to obtain gas sensors. The fire alarm described here, however, uses a simple, cheap, reliable and novel method of fire detection, is extremely versatile in that as many detectors as required can be added and will give enough warning to perhaps avoid another tragic disaster.

Fire Alarm

The fire alarm consists of two units: the master unit which sounds an alarm and displays where the fire is, and the detector units, one of which is mounted in each room. The master unit is intended to be mounted by the bedside in the main bedroom and to be switched on before a night's sleep. The unit has provision for six detector units, but this can be extended to any number if required. The unit supplies the power to the detectors, and when triggered sounds quite a loud warning device and illuminates an appropriates LED to show which detector has been triggered.

The detectors use a beam of infrared light supplied by an infrared LED to detect the presence of smoke particles. As the room fills with smoke, the intensity of the infrared (IR) beam reaching the IR detector transistor decreases, as the smoke particles scatter and absorb the IR light. This drop in intensity is detected and used to trigger the master unit.

When smoke is detected, a low signal is sent to the master unit; otherwise the signal is high. As the master unit expects to see a high voltage signal when in normal operation, any faults with the detectors and any breaks in the detector cables, which might be caused by fire burning through the cables, will be detected as the signal will go low and will trigger the alarm. This is an added safety feature which detects faults, as it is useless having a broken detector unit when you think it works perfectly.

Circuit Description — Master Unit

Power is obtained from transformer T1 (Fig. 1) through a fuse and is rectified and smoothed by D1, D2 and C1 to give a DC voltage of about 12V. This supplies IC1, the 555 timer, which is set to oscillate at about 1.5Hz. When TR1 is conducting, the signal from IC1 switches TR2 on and off which in turn switches the audible warning device (WD1) on and off. (If desired this warning device could be replaced by a relay which could drive a more elaborate alarm system — see Fig. 2.)

The signals from the detectors are fed to IC2, a CMOS hex inverter/buffer chip. The output voltage from this chip is the inverse of the input and is fed to the base of TR1 via R3 and diodes D11 to D16. A low voltage in produces a high voltage out which switches TR1 on and the alarm sounds.

The detector signals are also sent via R4 to R9 to a set of transistors (TR3 to TR8) which switch on LEDs D3 to D8 when the voltage to their bases goes low, hence showing which detector has been triggered. Resistor R16 and LED D9 are present to indicate when the unit is turned on.

Detector

The detector circuit is shown in Fig. 3.

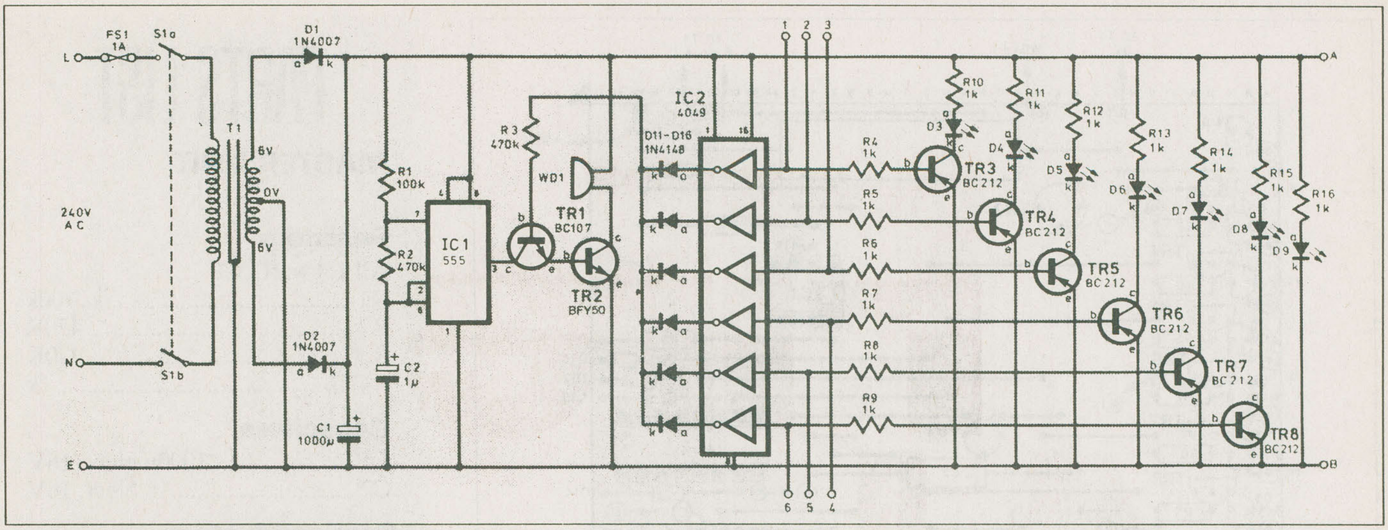


Fig. 1. Circuit of the Fire Alarm master unit.

About 50mA flows through the infrared LED D10 via R19 and R20 so that a high output of IR light is obtained. In the absence of smoke, this high intensity beam switches the IR transistor TR10 fully on so that the full supply voltage is dropped across R18 and the base of TR9 is at zero potential. Hence TR9 is not switched on, no current flows through R17 and there is no potential drop across it. The signal to the master unit is high.

When the intensity of the beam is reduced by the slightest amount, due to smoke particles, TR10 conducts less and so the base of TR9 sees a voltage. As the two transistors are directly coupled, this voltage switches TR9 fully on, the full supply voltage is dropped across R17 and the output signal is low.

Construction

The circuit board was made out of Veroboard, as this is the most available form of circuit board and allows the project to be made by less experienced builders who may not wish to purchase a ready-made PCB and who may be unfamiliar with PCB construction. As a result, however, there are quite a number of breaks in the tracks, and a large number of links are present so the layout shown in Fig. 4 will have to be very carefully followed.

A standard 3.75 inch X 5 inch Veroboard is cut to 29 holes and the off cut kept for the detector circuit board. Very carefully mark the breaks in the tracks and cut them with a razor knife or twist drill.

Start construction with the links, followed by the six stereo jack sockets. The resistors, capacitors and semiconductors

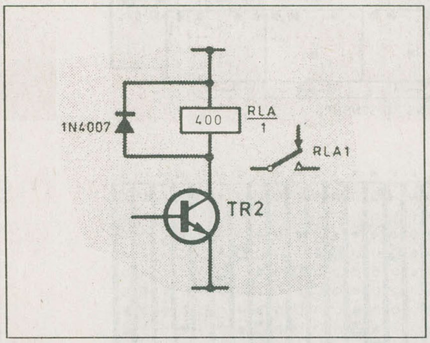


Fig. 2. Addition of a relay to drive other output devices.

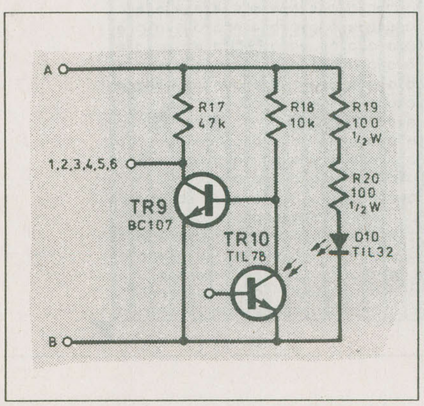


Fig. 3. Circuit of the alarm detector.

can then be soldered into place. Care must be taken with the orientation of polarized components (see Fig. 4). IC2 must be placed in a socket rather than directly soldered into the board (damage may occur due to the heat from the soldering iron, but IC2 is a CMOS device and none of the pins must be touched as this may cause damage to the chip due to static electricity).

Once the circuit board is complete, attention is now turned to the case construction and power connections. The case is a 152 X 82 X 50mm utility box, which accommodates the components snugly.

The transformer is mounted in the left hand corner using bolts and the fuse holder mounted at the back. The power cable enters the case through a grommet and a cable clamp should be included to prevent the power cable accidentally pulling out and weakening solder joints, which could be dangerous. Power wiring is shown in Fig. 5.

Six holes are drilled in the side of the case for the jack sockets and seven holes in the case lid should be drilled for the seven LEDs. The power switch S1 should be mounted in line with the power on LED (see Fig. 6). A hole will also have to be cut in the case lid for WD1 which should be fixed using epoxy resin.

After wiring up the circuit board, WD1, transformer, switch etc., (see Figs. 5 and 6) the circuit board can be mounted using bolts or the plastic spacers supplied with the case. All that remains is for the lid to be labelled with instant lettering.

Detector Unit

The few components which make up the detector unit are all mounted on a small piece of Veroboard left over from the main Veroboard. There is only one break to make and no links this time.

After construction of the circuit board has been completed (see Fig. 7) it is connected to the master unit via thin, 3-way power cable. The cable is attached to the circuit board as shown, fed through a grommet in the side of the case, and at-

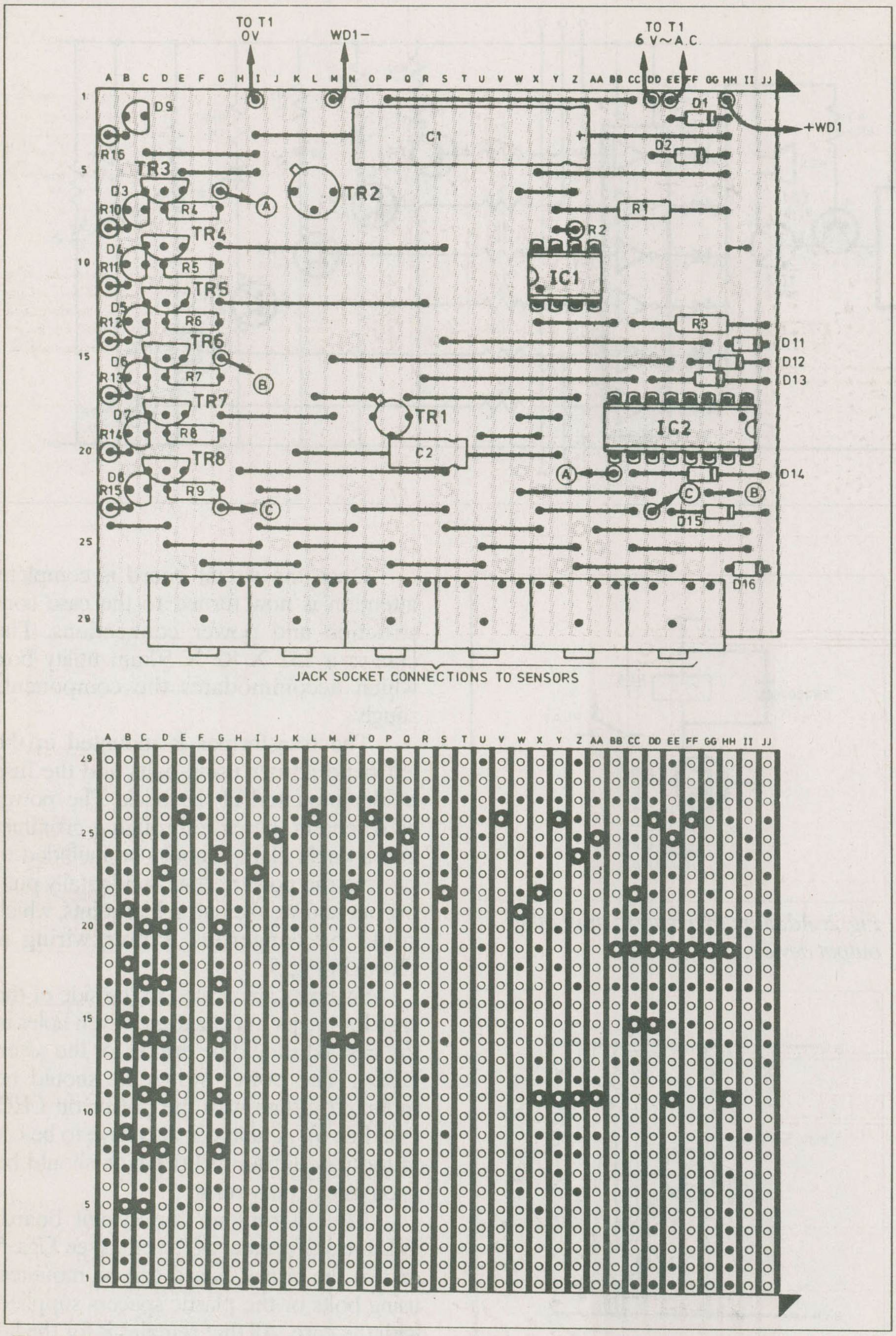


Fig. 4. Veroboard layout and wiring.

tached to a 3.5mm stereo jack plug, carefully noting which wire goes to which part of the plug (see Figs. 8 and 9).

Two holes should be drilled in the case lid so that the IR LED and transistor can poke through when the lid is placed on the case. The LED and transistor are then bent through 90 degrees so that they are facing each other, and are shielded from daylight, either by using a piece of pen case or rubber tubing. Particular attention should be made to shielding the transistor as external IR sources may interfere with the detector.

Plug the detector into the main unit and if the alarm is triggered, it means the LED and transistor are not correctly lined up with each other. If this happens, small movements of either the transistor or LED should be made until the alarm is silent.

Once alignment has been completed, the transistor and LED can be glued into place using epoxy resin. This also holds the

PARTS LIST

MASTER UNIT

Resistors

All 1/4 watt, 5%

R1 .... 100k
R2 .... 470K
R3 .... 470K
R4-16 .... 1k

Capacitors

C1 .... 1000u elect. 16V
C2 .... 1u elect. 16V

Semiconductors

D1,D2 .... 1N4007
D3 to D9 .... red LEDs
D11 to D16 .... 1N4148
TR1 .... 2N3904
TR2 .... 2N2219, BFY50, etc.
TR3-8 .... 2N3904, BC212, etc.
IC1 .... 555 timer
IC2 ...... 4049 CMOS hex inverter

Miscellaneous

FS1 .... 1A fuse and holder
S1 .... DPDT toggle switch
T1 12V centre-tap 6VA transformer
WD1 audible warning device: 12V buzzer, piezo sounder, horn, etc.
16 pin DIP socket, Veroboard 3.75 inch by 5 inch, case – 152 X 82 X 50mm, 6 stereo jack sockets, cable clamp.

DETECTOR UNIT

(Items for one unit)

Resistors

R17 .... 47k 1/4W
R18 .... 10k 1/4W
R19 .... 100 1/2W
R20 .... 100 1/2W

Semiconductors

D10 .... TIL32 IR LED
TR9 .... 2N3904, BC107, etc
TR10 .... TIL78

Miscellaneous

Case 72 X 47 X 25mm, Veroboard (see text); three-way power cable, 3.5mm stereo jack plug, grommet.

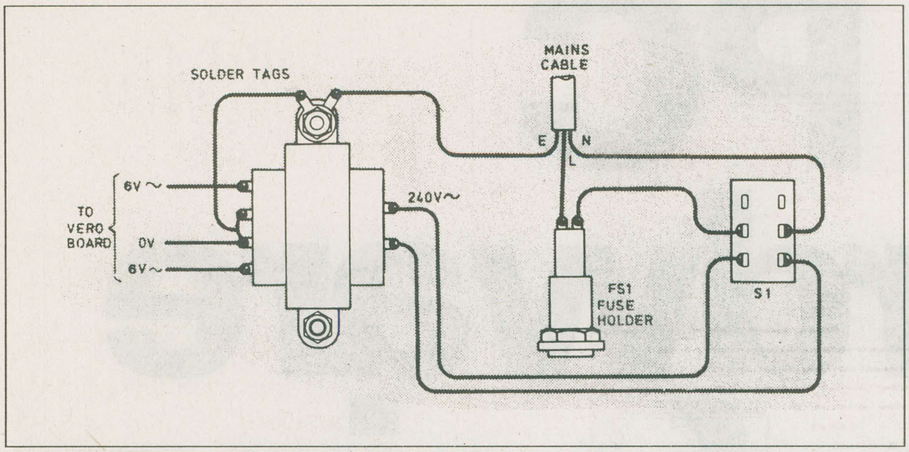


Fig. 5. Supply wiring.

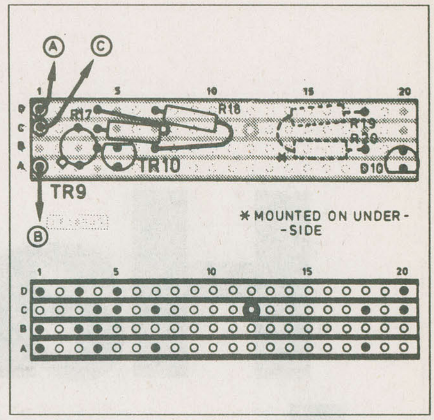


Fig. 7. Veroboard construction of the detector units. Note that point C goes to the jack plug tip.

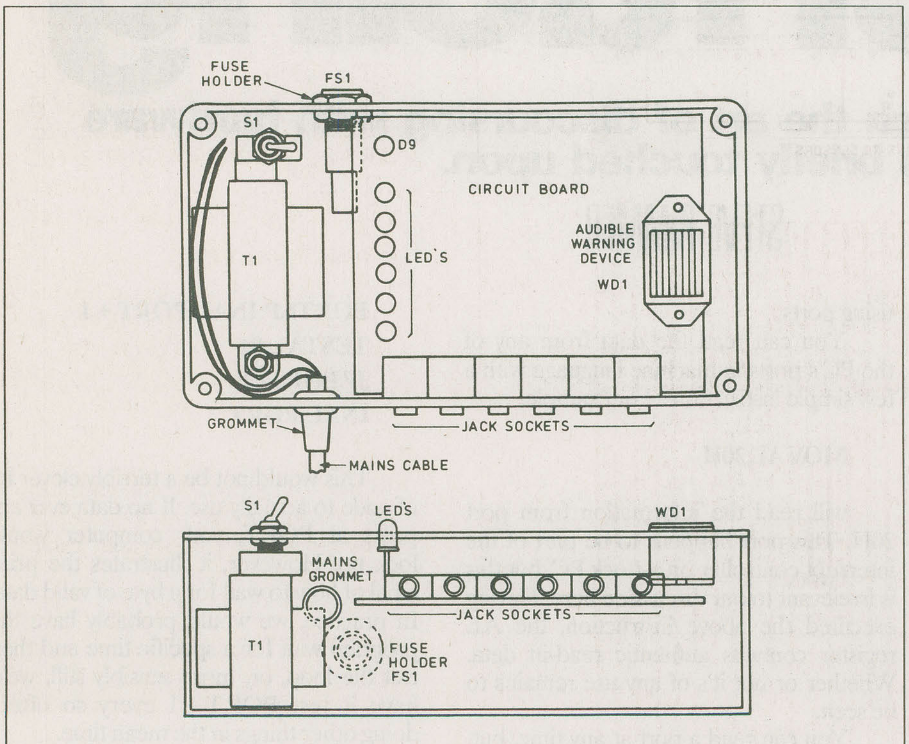


Fig. 6. Layout of the main components in the case.

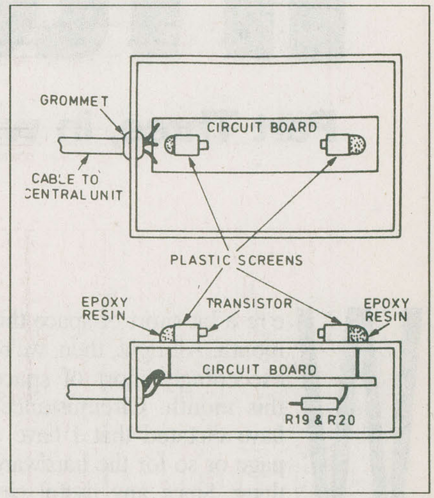


Fig. 8. Layout of the detectors.

circuit board in place. The detector is now complete.

Mounting and Testing

The detector units should be mounted high up on a room wall or on the ceiling as smoke tends to accumulate at the top of a room. Best positions are near potential fire hazards, e.g., near ash trays, electric heaters, above sofas, near electrical equipment etc., and detectors should be located as near to these as possible.

Testing is simply a case of cutting off the IR beam of each detector by placing a finger in the path of the beam, and checking to see if the corresponding LED lights. (You can also allow a little smoke from a cigarette to pass through the beam to check sensitivity.) If all is well, the project is now ready to protect your home from the dangers of fire. ■

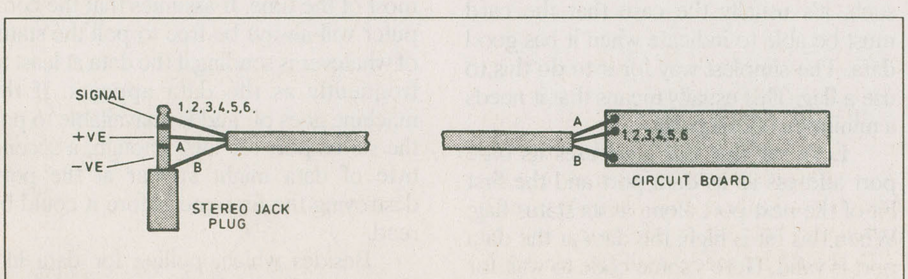


Fig. 9. Wiring of the detectors to the stereo plugs for connection to the master unit.

FEATURE

PC Hardware Interfacing

Part Three, in which the art of discoursing with hardware is briefly touched upon.

STEVE RIMMER

We're a bit short of space this month. All right, then, we're exceedingly short of space this month. Circumstances have dictated that I have a page or so for the hardware thing. Since any useful circuitry would take quite a bit more than this, we're going to look at a non-hardware part of hardware design for the PC. This time around, we're going to touch briefly on the software which talks to the boards we're going to be designing in the months to come.

It was going to get down to this sooner or later. The cleverest cards in the world are useless without software to drive them.

Any Old Port

As we've noted in the past two episodes of this saga, it's usually the case that one communicates with a peripheral card in the PC using ports. This isn't always the case. If we want to move a lot of data around, we might allow the card to read or write directly from or to the system's memory. This is called, not surprisingly, "direct memory access", or DMA. It's a complex subject on the PC, because the processor doesn't particularly like it. We won't be dealing with it here.

For the most part, though, we'll be using ports.

You can read the data from any of the PC's ports in machine language with a few simple instructions. For example,

```
MOV AL,20H
```

will read the information from port 20H. This port happens to be part of the interrupt controller on a stock PC, but this is irrelevant to our discussion here. Having executed the above instruction, the AL register contains authentic read-in data. Whether or not it's of any use remains to be seen.

You can read a port at any time, but, depending upon the design of the card which is driving the port, the data may or may not be good when you read it. As such, it's usually the case that the card must be able to indicate when it has good data. The simplest way for it to do this to use a flag. This usually means that it needs a minimum of two ports.

Let's say that our card uses its base port address as its data port and the first bit of the next port along as its status flag. When this bit is high, the data at the data port is valid. Here's some code to wait for good data and read it. We'll say that the base port is 300H.

```
PORTEQU300H

PORTLP:INAL,PORT+1
TESTAL,01
JZPORTLP
INAL,PORT
```

This would not be a terribly clever bit of code to actually use. If no data ever appears at PORT, your computer would lock up. However, it illustrates the principal of how to wait for a byte of valid data. In practice, we would probably have the program wait for a specific time and then exit the loop, or, more sensibly still, we'd have it test PORT+1 every so often, doing other things in the mean time.

The technique of checking for valid data like this is called "polling". It's not the most desirable way to read incoming data most of the time. It assumes that the computer will always be free to poll the status of whatever is sending it the data at least as frequently as the data appears. If the machine goes off and is unavailable to poll the status port for long enough, a second byte of data might appear at the port, destroying the first one before it could be read.

Besides which, polling for data like this wastes the machine's time. By rights, it should be able to ignore our peripheral card until some data actually shows up.

There is, of course, a better way. ■

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Interruptus

The proper way to handle this situation is to make the card send interrupts when it has data to give the PC, and to make the code which reads the card "interrupt driven". The only drawback to this is that there are very few available hardware interrupts available in a PC... most of them, as we touched on last month, are already spoken for.

We're going to use interrupt two here. It's not usually dedicated to anything. In complex applications, it's possible to avail the PC of extra hardware interrupts by daisy chaining it's internal 8259 interrupt controller chip to a second controller. We're not going to pry open this particular can of worms today, however.

In this example, let's say that our peripheral card is so designed that, rather than raising the first bit of PORT+1 to indicate the availability of data, it raises interrupt line two of the PC's bus. When this happens, the PC will immediately stop what it's up to, push its current code segment, instruction pointer and flag register onto the stack and leap to wherever the vector for this interrupt tells it to go.

Hopefully, the program which we've written to drive our card will have had the sense to point this vector to a suitable bit of code. The code which deals with a hardware interrupt is called a "handler".

This is a simple interrupt handler.

```
HANDLERPUSHAX
INAL,PORT

;DO SOMETHING WITH THE DATA

MOVAL,20H
OUT20H,AL
POPAX
IRET
```

An interrupt handler must always save all the registers it might corrupt onto the stack before it does anything and then restore them when it's done. In this case, only the AX register gets bopped. We can inhale the data from PORT with impunity, as we know that our card would only have thrown the interrupt if there was good data there. The handler would normally put the data somewhere so that it could be accessed by another program in a more conventional manner.

The next two lines of code signal that the interrupt is complete. Finally, we return from the interrupt with an IRET instruction, which will put us right back where we started before the interrupt took place. So long as we have preserved everything properly, the interrupted program will never know that anything happened.

And Then We Were Three

There's a lot more to it than this, of course. Next month we're going to get back into the seething world of hardware design, but we'll be doing so with some of the things we've looked at here in mind. It's important to understand the relationship between hardware and the software which will drive it if one's peripheral cards are not to become the doorstops and hamsters' grave stones of generations yet unborn. ■

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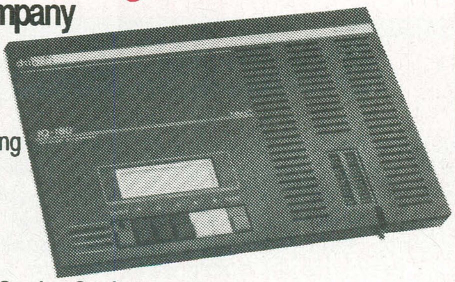

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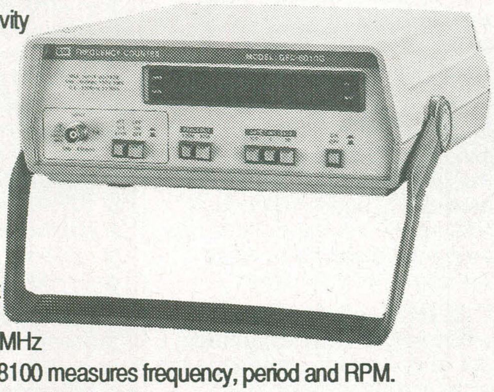
Circle No. 63 on Reader Service Card

Multi-Function Counters
GW Instruments GFC/GUC — Series



Typical features include:
- Extra low sensitivity 10 mV rms
- Eight digit LED display

Model:
- GFC8010 120 MHz
- GFC8055 550 MHz
- GFC8100 1 GHz/120 MHz (Dual Input)
- GUC2010 100 MHz

Model Shown GFC8100 measures frequency, period and RPM.

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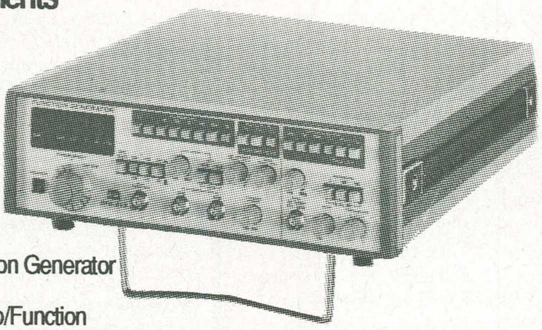
Multi-Purpose Generators
GW Instruments
GFG Series



With an exceptional combination of functions and features.

Model:
- GFG8015 2MHz Function Generator
- GFG8016S 2MHz Sweep/Function
- GFG8016D 2MHz Multi-Function Counter
- GFG8019 2MHz Sweep-Function + Counter
- GFG813 13MHz Multi-Function/Counter

Model Shown GFG813 provides 6 digit display, 20V p-p output

Circle No. 64 on Reader Service Card

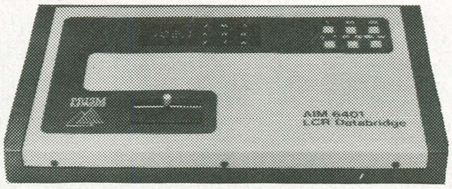
3200 Count Digital Multimeters
Soar Series 3200

Features:
- 3200 Count Digital Display
- Full 32 segment Bargraph Display
- Standard or Drop Proof Cases
- Special Functions: Data Hold, Range Hold

Measure:
- Voltage to 750VAC/1000VDC
- Current to 10A AC/DC
- Resistance to 32M OHMS
- Optional Plug-in modules for Temperature
- AC/DC Current, Capacitance & Transistor hFE

Circle No. 62 on Reader Service Card

Automatic LCR Bridge
Prism Electronics
Model 6401



Features:
- Measure R, L, C, and Q automatically
- Eight decades of LCR measurement
- Series or parallel measurement modes
- Four digit LED display
- Basic accuracy; 0.25% of reading

Circle No. 65 on Reader Service Card

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